Exploring Green Industrial Policy in South Africa through the Lens of Vertically Specialized Industrialization

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David Murray

Supervisor: Britta Rennkamp, Ph.D

University of Cape Town

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Abstract

Through various policy mechanisms deployed in the last seven years, the South African government has pursued the localization of renewable energy manufacturing. These efforts are related to the Department of Trade and Industry's broader goals to industrialize the South African economy by increasing the range and value-add of domestically manufactured products. This thesis uses global value chain analysis to determine what ways local wind and solar manufacturing firms relate to this goal by pursuing innovation, upgrading, workforce development, and regional market penetration strategies. The author uses the theoretical framework of Vertically Specialized Industrialization (VSI) as outlined by Milberg, Jiang, and Gereffi as the basis for assessing firm-level governance strategies. The research was performed through semi-structured telephonic interviews with senior level staff at renewable energy firms and non-governmental organizations, as well as a review of public reports. The findings revealed that wind and solar firms are not significantly pursuing upgrading or innovation strategies as associated with VSI. This is likely the result of insufficient market demand and policy incentives, as well as competition from countries with comparative advantage.

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Abbreviations and Acronyms

AfDB: African Development Bank
DTI: Department of Trade and Industry
EOI: Export Oriented Industrialization
EPC: Engineering, Procurement and Construction
EPF: Economic Policy Forum
EPZ: Economic Processing Zone
FDI: Foreign Direct Investment
GVC: Global Value Chain
GW: Gigawatt
IFC: International Finance Corporation
IPAP: Industrial Policy Action Plan
IP: Industrial Policy
IPP: Independent Power Producer
ISI: Import Substitution Industrialization
kWh: Kilowatt-Hour
LCR: Local Content Requirement
MEC: Minerals-Energy Complex
MNC: Multi-National Corporation
MW: Megawatt
NGO: Non-Governmental Organization
OECD: Organization for Economic Co-Operating and Development
OEM: Original Equipment Manufacturer
PPA: Power Purchase Agreement
R&D: Research and Development
RE-IPPPP: Renewable Energy - Independent Power Producer Procurement Program
SACU: Southern African Customs Union
SADC: Southern African Development Community
SEZ: Special Economic Zone
TIS: Technology Innovation System
VSI: Vertically Specialized Industrialization
WASA: Wind Atlas of South Africa
WTO: World Trade Organization

Definition of Terms

Vertically-Integrated Utility: Owning all segments of the electricity market, from generation and transmission to distribution.

Minerals Energy Complex (MEC): A term coined by Fine and Rustomjee in 1994 to describe the mutually supportive, powerful industries of South Africa. Historically, this referred to the mining and minerals industries, energy sector, and public and political institutions.

Enclave Economy: A market sector that is largely defined by an extractive industries and foreign capital, and largely differentiated from the surrounding of local market. Many African nations are considered enclave economies, where high-value natural resources are extracted by international firms while other sectors of the economy rely on low-value activities.

Dutch Disease: Based on the experience of the discovery of a natural gas field in the Netherlands, the "Dutch Disease" refers to a situation where sharp increases of foreign direct investment result in appreciated currency, thereby making the export of domestic goods more challenging. In the case of South Africa, the post-Apartheid "Dutch Disease" resulted in increased exports from the mining and minerals sector at the expense of manufacturing and agriculture sectors.

1. Introduction

By 2016, South Africa became one of the top ten countries for renewable energy development despite its historically high dependence on coal in electricity generation (International Renewable Energy Agency [IRENA], 2016). South Africa is home to the flagship renewable energy deployment program of Africa, and domestic industries boasted more than 400 MW of solar panel and significant wind turbine manufacturing capacity (IRENA, 2016). The presence of global renewable energy firms is not by chance; a wave of local public policies favoured the diffusion of renewable energy technology. The national government developed renewable energy manufacturing policy in conjunction with larger efforts to industrialize the domestic economy. The Department of Trade and Industry (DTI) signalled industrialization was to be pursued in part by integration into global value chains (GVCs). Hence, this thesis deploys a global value chain analysis framework to explore how domestic solar and wind manufacturing firms fit into a broader industrial goal of international market integration. Using Milberg, Jiang and Gereffi's (2013) observations on policy necessary for GVC-based industrialization, the research seeks to determine how local renewable energy firms are pursuing innovation, upgrading, and regional market integration. Are these actions similar to Milberg, Jiang and Gereffi's prescriptions, and if so, how? If not, what are the reasons for pursuing these goals?

1.1 Statement of the Problem(s)

Historically, energy use correlated with economic growth (Sadorsky, 2014). Emerging economies effectively are charged with growing electricity capacity in order to fuel industrialization and greater access to power. Yet in an era of global climate agreements, these same nations face pressure to reduce carbon emissions and pursue cleaner forms of energy generation. In theory, renewable energy firms in developing countries can leverage a "green industrial policy" to meet the shared goals of economic growth and environmental benefit. On the other hand, building local green industry may prove costly, uncompetitive, or inefficient, and thus should not be a top priority for public policy.

Thus, this research aims to explore the nature of the renewable energy manufacturing sector in the context of global value chains. It seeks to evaluate the strategies deployed by wind and solar firms to integrate into the international market, and determine how this resembles a modern industrialization pattern. Thus, it is ultimately a study on industrial policy, sharing evidence of the challenges to construct a manufacturing sector in a developing African country. This following section will examine relationship

of the industrial policy with renewable energy deployment, and shed light on the origins of the South African renewable energy manufacturing sector.

Industrialization in a Globalized Society

Industrialization poses a unique challenge to South Africa. On one hand, the country stands apart from the rest of the continent, especially Sub-Saharan Africa. It is home to largest economy, and among the highest in literacy (94%), electrification (93%) and sanitation access (66%) (African Development Bank Group [AfDB], 2017). On the other hand, the country struggles with the same challenges as the remainder of the region: overdependence on natural resource extraction, economic and racial stratification, and vast unemployment for unskilled labour. Like other African nations, South Africa is prioritizing industrialization to grow its economy, but also develop a skilled workforce to provide pathways to the middle class for historically marginalized populations.

History reveals a pattern of resistance to this initiative. Fine and Rustomjee (1996) coined the term "minerals energy complex" to define South Africa's distinctive political economy. The MEC holds that the historical extraction of coal and minerals, on the back of cheap labour under the apartheid regime, enabled an iron triangle – a system of public and private actors that use financial and political resources to ensure mutual strength. In the case of South Africa, these actors consisted of the mining, power, and public sectors. Industrial policy was informal, implicitly built to favour the continuation of these industries. Meanwhile, black citizens had restricted access to skills development, severely limiting participation in industries that providing middle class wages. Manufacturing that was not linked to the MEC was meant to build an import-substitution based economy, necessary to weathering economic sanctions during apartheid. The democratic transition in 1994 fostered a punctuation in the policy regime, transforming industrial policy.

The new republic faced a daunting array of challenges after the transition. Trade liberalization caused a once-protected manufacturing sector to compete with cheap imports. In the beginning of the 21st century, capital intensive, resource based sectors grew while downstream, value-added, and labour intensive sectors declined (Mohamed, 2012a). Even by 2011, 59% of South African exports consisted of primary products or natural resources (Gereffi & Sturgeon, 2013). Meanwhile, the minerals-energy industries went global: financialization of commodities enabled capital to leave South Africa. This meant fewer taxable resources for a government struggling to build a new economy.

Employment and workforce development was- and unfortunately remains-- a major concern. Unemployment afflicted one quarter of the country's labour force, and disproportionately impacts previously disadvantaged citizens (Mohamed, 2012a). Education plays a major role: historically excluded from workforce development, non-white workers lacked access to better-paying, skilled job opportunities. Education attainment is inversely correlated unemployment; skilled sectors even reported difficulty filling positions despite a large labour pool (Lam, Liebbrandt, and Mlatsheni, 2008). Thus, social concerns provided another reason for growing sectors, such as manufacturing and textiles, which rely upon skilled workers. South Africa could no longer rely upon minerals to drive its economy; it needed to diversify into new industries that would create jobs and boost exports in an increasingly competitive global economy. Emerging literature, which will be discussed later at length in this paper, suggested the government develop a strong industrial policy that could yield strategic upgrading within global value chains.

Key government initiatives, such as the Industrial Policy Action Plan and the New Growth Path (NGP), revealed the nature of this transition (Department of Economic Development, 2011; Department of Trade and Industry [DTI], 2011). Rob Davies, Minister of Trade and Industry, stated in 2012 that "the problem for us in developing countries is that we need to move higher up the VC [Value Chain] and industrialize our economies" (Cape Town, 2012). The DTI developed policy to add value to the existing mining, agriculture and pharmaceutical sectors. It also considered regional approaches to industrialization: negotiating trade agreements and infrastructure to develop southern Africa (Davies, 2012). South Africa retail, textiles, and telecommunications firms soon were expanding throughout the region. However, industrialization was markedly limited a number of key factors: poor access to capital, lack of adequate skills, transportation costs, and a substantial electricity shortage.

Shortcomings in the electricity grid are a major concern to industrial development because energy access and infrastructure are historically correlated with economic growth. Sadorsky (2014) found that industrialization can increase electricity demand because the economy develops more energy intensive activities, such as manufacturing and minerals processing. Furthermore, the increase in wages that may accompany industrialization spurs electricity demand. As more citizens have disposable income, they are able to afford televisions, refrigerators, and other products that require electricity. Therefore, should policymakers plan for industrial development, they must also plan for greater energy supply.

Enter Clean Energy: A Solution to a Multi-Faceted Problem?

Despite containing substantial generation capacity, electrification is an important challenge for South Africa. South Africa faced an energy crisis throughout the early 21st century; under-capacity and poor supply infrastructure required temporary power-cuts, or "load-shedding". Approximately 14% of the country's population lack access to grid electricity, a problem marked by both technical and financial barriers (World Bank, 2016). Coal accounted for over 90% of primary electricity supply; declining resources prompted discussion over diversification. Meanwhile, mounting pressure from the international community to reduce carbon emissions weighed on a nation that had the highest per capita emissions in Africa, with an average rating higher than that of the European Union (United Nations Framework Convention on Climate Change [UNFCCC], 2016). Therefore, South Africa faces multiple challenges: boosting generation capacity, expanding access and diversifying supply, while reducing reliance on fossil fuels. With high levels of wind and solar irradiation, clean energy was touted as an integral solution.

Indeed, the New Growth Path Framework of 2010 identified renewable energy development and manufacturing as a key mechanism to address socioeconomic and electrification concerns (Department of Economic Development, 2011). Following the NGP, the 2011 Green Economy Accord (GEA) brought together stakeholders in government, educational institutions, labour unions, utilities and the private sector. An explicit coalition building exercise, the GEA marked a considerable effort to spur the development of a new industry in South Africa. The GEA laid out steps to localize renewable energy manufacturing, further research and development, and create jobs in the sector. It also called for procurement of 3.75 GW of renewable energy by 2016 (South Africa did not meet this goal) (GreenCape, 2016).

On the generation side, the Integrated Resource Plan (IRP) of 2010 specifically called for 8.4 GW of wind and 9.4 GW of solar; renewable energy was to represent 42% of new generation installed by 2030 (Department of Energy, 2010). To meet the goals of the 2010 IRP, the Department of Energy implemented the Renewable Energy – Independent Power Producer Procurement Program (RE-IPPP). The RE-IPPPP, initiated in 2011, uses a tender process to issue PPA's to IPPs responsible for connecting renewable energy projects with the state-owned utility, Eskom. Nearly 7 GW of renewable capacity has been approved under the RE-IPPPP, with over 2 GW of generation already powering the grid at the time of this publication. It is worth noting that subsequent bids will require cooperation with Eskom, which is

in question given the utility's announcement in the winter of 2016 that it would not be accepting additional PPA's beyond Round 4.5 (Spencer, 2016).

The 2010 IRP remains policy until an update is promulgated. In November 2016, the Cabinet released an updated Integrated Resource Plan, which is still under consultation and comment period. While the plan calls for 17.6 GW of PV capacity and 37 GW of wind by 2050, there has already been significant criticism from both the solar and wind energy industry as there are outdated cost calculation and seemingly arbitrary constraints on renewable energy delivery (Yelland, 2016). The Update reports 1 GW per year for solar PV and 1.6 GW per year for wind.

Generation outside of the RE-IPPPP has been limited, as the state-owned, vertically integrated utility, Eskom, constrains private sale of utility scale electricity. The DTI estimates that large scale wind generation outside the RE-IPPPP will be between 458 MW and 6.8 GW by 2030, a considerable range (DTI, 2015:xii). Residential and commercial solar projects, which have grown in recent years, could further develop offset fossil generation. However, development depends on a diversity of individual decision-makers, including municipalities and private business owners.

The renewables sector reflects many industries described in the global value chain analysis framework. Both wind and solar have undergone tremendous globalization in recent years. This caused Schmitz and Lema (2015:118) to note the increasing difficulty of "defin[ing] the national content of a wind turbine or solar panel" as both production and innovation takes place in several countries.

Integrating Goals: Green Industrial Policy

A suite of economic development and renewable energy deployment policies- particularly the RE-IPPPP- made it clear that government intended for renewable energy development to accompany socio-economic initiatives of job creation, community empowerment, workforce development and industrialization. If the government were to deploy hundreds of wind turbines and thousands of solar panels, it would be appropriate to assembly and manufacture many of the components in South Africa. Localization became a key component of the program.

The Industrial Policy Action Plan (2014/2015) included an incentive program to support upgrading into energy efficient or renewable technology (DTI, 2015). The DTI offers grants, loans and tax rebates supporting green industrial development, providing favourable financing toward solar and wind manufacturing industries. Special Economic Zones (SEZs) were created in Upington and Atlantis to draw a multitude of solar and wind (respectively) component manufacturers. By opening doors in these SEZs,

companies have access to reduced corporate tax rates, employment tax incentives, accelerated depreciation on capital structures, VAT and customs relief.

The RE-IPPPP stipulated local content requirements on all tenders, with the target increasing as the domestic industry was to mature. The value of local content (as a percentage of net project value) was targeted in the long term at 65%, the current threshold is at 40%. It is worth noting that bids were evaluated on a number of metrics, with economic development goals formally weighted at 30%. However, industry officials surmise it is less in practice (Baker, 2015). Local content requirements make up a quarter of the total economic development weighting, suggesting it is approximately 8% of the total weight of the bid.

The DTI notes that potent policies to create a local wind manufacturing industry- aside from spurring domestic capacity- include forming joint ventures with international companies, robust local content requirements, and strategic trade policies to support local manufacturers. All of these factors are demonstrated in South Africa. But to what end?

Current Status of the Wind and Solar Manufacturing Industry

As expected, the generous and long-term renewable energy procurement program attracted a number of wind and solar companies from China to Denmark to the United States. South Africa is home to major solar and wind manufacturing firms, as well as joint partnerships between foreign firms and local companies.

The increase in local content in subsequent rounds of the RE-IPPPP suggests there has been measurable progression in localization. In the first round of the IPP, local content of wind projects averaged 27%, whereas by the second and third rounds local content approximated 47%. Most of the domestic material sourced from the first round supported the balance of plant value, such as the foundation or transportation expenses. By the third round, local components included towers, meteorological masts and anchor cages. For the solar industry, local content levels rose from 38% in the first round to 64% by round four, indicating even greater progression to localize assembly and manufacturing (Eberhard, Leigland & Kolker, 2014).

Yet the future is unclear for both the wind and solar manufacturing industries. On one hand, South Africa has policy initiatives in place to support local renewable generation and manufacturing, expertise in linked industries, presence of global firms who are outsourcing component manufacturing. This makes a strong case for industry upgrading and growth. Yet on the other hand, the future rounds of the

RE-IPPPP is uncertain, and prospects for future domestic demand is generally restricted to the RE-IPPPP. That is especially a concern for the utility scale wind industry, which has a smaller market in the commercial and residential sectors. South African manufacturers would also have deal with a global glut in production, competition from Chinese imports (which received subsidies), and a limited export capacity (DTI, 2015:xix).

As for distributed generation, there are opportunities for growth. The price of electricity is expected to rise above inflation for the foreseeable future; thus it would be prudent for businesses and property owners to invest in distributed energy systems, such as a solar array (GreenCape, 2016). In 2016, a number of local municipal guidelines emerged to foster a better understanding of developing embedding generation. Banks have already started to offer industrial consumers funding opportunities for rooftop PV. However, a suite of barriers remains, including policy gaps, high capital costs, and unregulated tariff structures (GreenCape, 2016).

There are regional opportunities, but the prospects are limited. Twenty-eight other countries in Africa have renewable energy targets, with some mandating the capacity of wind of solar energy by a specific date. This not only is a result of reduced global costs, but policies to increase capacity, diversify to cleaner sources of energy, and hedge against reduced hydropower capacity as a result of climate change. Estimates that 12.5 GW of wind power will be installed in sub-Saharan Africa over the next fifteen years (DTI, 2015:x). IRENA (2015) suggested that an ambitious suite of policies could result in 40 GW of solar deployed in Africa.

As noted above, the state of the solar and wind manufacturing industry in South Africa is both dynamic and uncertain. It is unclear the extent to which the domestic industry will participate in regional renewable energy markets, and upgrade into new products and processes.

The Purpose of Study

Thus, this research seeks to reveal in what ways the clean energy industry can align with the long term industrial goals of South Africa. The study assesses local firms' added value in the South Africa renewable energy market, role in domestic skills development, relationship to international solar and wind companies, and prospects for upgrading and expanding into neighbouring markets.

As underscored by the 2010 Green Economy Accord, it is a priority for South African Cabinet ministers, organized labour, business groups, and community organizations to not only localize solar and wind manufacturing, but develop a workforce capable of high value add activities. A local industry should

become a regional hub of production and technical expertise, exporting components to growing renewable energy markets in the region (DTI, 2011). Yet as the South African solar and wind industry struggles to compete against foreign prices and innovation patterns, one might consider clean energy manufacturing a fledging dream of industrialist and environmentalists alike.

Theoretical Framework

This research uses global value chain analysis as a means of exploring the renewable energy manufacturing industry in South Africa.

Globalization, the rapid ascendance of East Asian countries in the services and manufacturing sectors, and the mobility of capital have shifted traditional theories on industrialization. Milberg, Jiang and Gereffi (2013) posit that developing countries must pursue vertically specialized industrialization (VSI) as a means of industrial policy. Developed within the global value chain analysis framework, VSI stresses the role of intermediate inputs, upgrading and innovation, regional trade agreements and governance among multinational corporations (lead firms) as central to economic development. Schmitz and Lema (2015:126) go further to highlight the important intersection between GVC analysis and innovation systems. The authors note that the "essence of value chain analysis…was extended to the innovation process" in order to determine where innovation takes place at each stage of production.

Hence, this research seeks to ascertain governance strategies of solar and wind manufacturers. The primary goals of the interview all relate to aspects of VSI: innovation, upgrading, skills development, regional market growth and trade.

There is limited literature producing micro-level data in this sector as the South African industry is quite young (Pahle, Pachauri & Steinbacher, 2016). Furthermore, there is no research that uses vertically specialized industrialization as a benchmark for the South African renewable energy industry. As this approach is unique on several levels, the extensive literature reviews uses case studies of clean energy industrialization in China, Europe, and India as examples (Schmitz & Lema 2014; Iizuka, Dantas & Freitas, 2015; Zhang & Gallagher, 2016). It also relates case studies in South Africa of other industries that have been implemented under the GVC or innovation systems framework (Milberg, Jiang & Gereffi, 2013; AfDB, 2014). Finally, it is informed by numerous studies of the South African renewable energy industry as whole, gleaning specific information about the manufacturing industry throughout (Eberhard, Leigland & Kolker, 2014; Baker, 2015; DTI, 2015).

Research Question

In the literature review, this paper examines South Africa's industrialization patterns, and contextualizes it within Milberg, Jiang, and Gereffi's (2013) Vertically Specialized Industrialization. This informs the main research question: in what ways are solar and wind manufacturing firms a part of DTI's broader efforts to industrialize through Vertically Specialized Industrialization? More specifically, how are local firms are pursuing innovation, upgrading, and regional market integration? Alternatively, what are reasons businesses might not be implementing these governance strategies associated with Milberg, Jiang and Gereffi's (2013) policy prescriptions?

Given the policy stipulations in RE-IPPPP, workforce development program and SEZs established by the government since the early 2010's, the author supposes that the South African national government envisions solar and wind manufacturing as an important component of industrialization through vertical specialization. However, given the steep competition from Asia, and market uncertainty in domestic and regional markets, the opportunities for upgrading may be limited. This suggests South African wind and solar manufacturing firms are not responding to public incentives by currently pursuing governance strategies associated with VSI. Therefore, renewable energy firms are not yet contributing significantly to the government's broader industrial policy priorities.

Significance of Study

The subsequent research can inform policymakers and business leaders of the state of the renewable energy industry, and policy mechanisms necessary to engender a stronger commitment to upgrading on part of the local industry. The results will indicate to other countries looking to emulate South Africa's renewable energy industry, using its pathway as a means of avoiding future pitfalls. Finally, this research will highlight the importance of using global value chain analysis as an industrialization framework for South Africa. Thus, the results of this study provide both theoretical contributions and qualitative analysis to the global value chain research and green industrial policy.

2. Literature Review

This literature review is organized into two parts, a theoretical and empirical review. Part One will first outline major theoretical underpinnings of industrial policy, and subsequently discuss a contemporary framework for industrial policy study, known as global value chain analysis. Through the lens of global value chain analysis, a new theory of industrial policy emerges that is particularly relevant to South Africa: vertically specialized industrialization, also known as global value chain oriented industrialization. The final chapter of the first section will integrate theories around green industrial policy into this framework.

The second section begins by assessing how vertically specialized industrialization is relevant in other countries, and proceeds to discuss South Africa's industrialization pattern through a global value chain analysis framework.

2.1 Applying a Theoretical Framework of Green VSI

This chapter will underscore why global value chain analysis, in particular vertically specialized industrialization, is a suitable theoretical framework to evaluate in what ways the renewable energy sector is a part of the South Africa's government's broader industrialization goals. It will begin by introducing global value chain analysis, and subsequently describe vertically specialized industrialization. Next, it will provide a summary of historical applications of IP, and how these theories shaped the basis for VSI. Finally, it will explore green industrial policy, and how its applications can relate to the South African renewable energy manufacturing sector.

2.11 Industrialization through Global Value Chains

Globalization placed greater power on multinational firms to influence domestic industrialization patterns. One piece of evidence of this phenomenon was the progressive disaggregation of supply chains. Production chains became dispersed as transportation, communication, and automation became more efficient and cost-effective (Dalle, Fossati & Lavopa, 2013). Western corporations relied more on the capacity of many domestic suppliers in developing countries for manufacturing, assembly and light processing. The growing buying power of emerging markets, coupled with the declining influence of the

World Bank and World Trade Organization, turned attention away from industrialized countries and onto the importance of bilateral and regional trade agreements in the developing world (Milberg, Jiang, & Gereffi, 2013:166). As world trade surged, so did the average input content of exports: indicating that the trade of intermediate goods was underpinning industrial development (Dalle, Fossati & Lavopa, 2013:2).

As global production networks, also known as global value chains (GVCs), became more complex, it became increasingly difficult for policy to distinguish between liberalization and protectionism. For example, an import, such as French cork used for wine, might ultimately contain high export content. On the other hand, an export, like processed minerals, could contain high import content from other mineral-rich African neighbours. In light of these complexities, global value chain analysis emerged in order to explain a rapid growth in trade of intermediate goods and volatility of world trade (Milberg, Jiang & Gereffi, 2013:152).

In the framework of global value chain analysis, the key question for policymakers in developing countries is how to create and add value within international supply chains. Rather than creating vertically integrated industries, states were charged with identifying a stage in a supply chain that it may have comparative advantage, and seeking lead firms as to act as buyers. In this manner, the vertical specialization of goods led to emerging literature exploring how integration into global value chains furthers industrialization goals (Milberg, Jiang & Gereffi, 2013; Rodrik, 2014).

The GVC framework stresses cross border, rather than local linkages. This underscores the role of multinational firms, international trade agreements, and regional markets. Gereffi and Fernandez (2011) suggest a value chain analysis is performed by analysing all "activities firms and workers perform to bring a specific product from its conception to its end use and beyond" (14) In this manner, the framework yields two approaches for an analysis. The value chain, or 'top-down,' approach looks at governance and the organizational importance of global industries and lead firms. One may also characterize this as the *internationalist* approach, as analysis deploys macro-level data, such as trade agreements and foreign direct investment. On other hand, the *industrialist*, or 'bottom up' methodology uses a micro approach, assessing the competitiveness of local firms and clusters industry through qualitative data and case studies (Morrison, Pietrobelli & Rabellotti, 2008). This "bottom up" approach also emphasizes local innovation systems and public institutions (Gereffi & Lee, 2012). As this thesis explores public policies relating to upgrading strategies among South African supplier firms, it will deploy an industrialist, "bottom up" approach.

Indeed, there is a need for greater research into bottom-up analysis of global value chains in developing countries. Morrison, Pietrobelli and Rabellotti (2008:51) point out a lack of clarity in "how GVCs foster innovation learning processes in developing countries… a harmful neglect of the analysis of the detailed mechanisms linking value chains with local firms' learning and innovation." The authors conclude by suggesting firm-level surveys in order to assess how GVCs impact local businesses' upgrading and competitiveness. In essence, upgrading is at the crux of industrialization through global value chain integration, and will be explored in the next section.

Upgrading and GVC-Oriented Industrialization

In order for an economy to maximize economic gains from their role in the globalized supply chain, local firms must continuously innovate and perform higher value activities. Humphrey and Schmitz (2002:3) characterize this as "upgrading," defining it as "increasing the skill content of activities and/or move into market niches which have entry barriers," and are thus insulated from global competitors. Put simply by Pietrobelli and Rabellotti (2006:1), industrial upgrading is the ability of producers to "to make products more efficiently, or to move into more skilled activities." Humphrey and Schmitz (2002) distinguish four types of upgrading:

i) Process Upgrading: improving the efficiency of production through advanced technology
ii) Product Upgrading: increasing the value per unit
iii) Functional Upgrading: gaining new functions, thereby increasing the skill of the activity
iv) Inter-chain Upgrading: moving into other sectors

Noting the successful experience of East Asian firms it could advised states pursue upgrading strategies in this particular order (Humphrey & Schmitz, 2002). For example, a country may first take on original equipment assembly, then original equipment manufacturing, own design manufacturing and finally to own brand manufacturing (Gereffi, 1999). In this manner, a country generates employment that increasingly demands higher skill levels, and therefore greater value-add, from exports. According to Milberg, Jiang and Gereffi (2013:151), "economic development now occurs as a process of 'industrial upgrading' within GVCs".

Vertically Specialized Industrialization (VSI)

In order to evaluate mechanisms enabling industrial upgrading, one must not only examine domestic policy but governance strategies of local firms. In this manner, global value chain analysis accommodates the nuances of industrialization in a globalized economy. Industrialization is no longer

based entirely in protectionism of infant industries, but rather the strategic relationships between foreign and local firms. States can achieve industrial goals by integrating into select links of a global value chain, and subsequently upgrading within these chains. Milberg, Jiang and Gereffi (2013) characterized this phenomenon as "Vertically Specialized Industrialization" or VSI. As Export Oriented Industrialization (EOI) was no longer considered a realistic mechanism for development, Milberg, Jiang and Gereffi (2013) presented VSI as "the only option open to developing countries in the current epoch" (Newman & Takala-Greenish, 2014:12).

The basis of VSI is the trade of intermediate goods, and gradual upgrading along the supply chain in order to ultimately specialize in higher value-add activities. A country encourages imports for assembly (low value add), thus starting with a high level of vertical specialization. Ideally, this strategy leads to local manufacturing by foreign-owned firms, and eventually manufacturing by locally-owned firms. Vertical specialization is reduced at this stage, but the value-add to imports has increased. Finally, the state increases vertical specialization once more, by outsourcing low value add activities, and focusing on design and marketing. This is challenging step for middle income countries, as it reduces employment in the sector and demands consistent innovation policy.

Like earlier patterns of industrialization, Vertically Specialized Industrialization relies on short and long term industrial policies. The state is responsible for coordinating development strategies with NGO's, public institutions, domestic suppliers, and trans-national corporations. However, unlike EOI or ISI, VSI is driven by international market forces, where domestic suppliers can bargain with a diverse set of lead firms. Thus, the state's role is inherently limited in guaranteeing upgrading, as business strategies (i.e. governance) are crucial to foster upgrading.

VSI is a marked change from the historical applications of the industrial policy, as it not only recognizes the rise in trade of intermediate goods but stresses the importance of the firm in pursuing upgrading and innovation. As explored later, industrial policy has centred on the role of the state in shaping a domestic market. The subsequent sections demonstrated how states have increasingly relied on global trade and multinational firms as a mechanism for industrialization.

Theoretical Roots of IP

The theoretical basis for industrial policy rests upon classic theories of international trade. Comparative advantage articulated by Ricardo (1817) suggested countries should specialize in producing goods at lower opportunity cost than others, therefore realizing the greatest level of economic welfare. This

theory led to the development of the Heckscher-Ohlin (1933) model of international trade. The H-O model proposes countries will export products based upon their abundant resource factor endowments, while scarce resource endowments are imported. Factor endowments may include durable and non-durable goods, labour, or human capital. The H-O model suggests countries with cheap labour resources, such as developing nations, should specialize in labour intensive activities, such as manufacturing or textiles, where products can be produced cheaply with low wages.

By extension, the Heckscher-Ohlin model incorrectly implies countries in Sub-Saharan Africa would develop robust manufacturing industries. Wood and Berge (1997) thus modify the H-O model by factoring in skill and land endowments along with the traditional relationship between capital and labour. The authors conclude that in a globalized world with mobile capital, low skill and land ratios may in part explain why certain developing countries export primary products instead of manufacturing. Natural resource-rich countries struggle to develop, as the lack of a manufacturing sector relinquishes technical progress and opportunities for skills development. As explored later in this paper, this hurdle has plagued South Africa, and further compounded by a long history of racial oppression. In order to overcome barriers to industrialization, state intervention becomes necessary.

Hamilton (1791) and List (1841) developed ideas to articulate how public policy could act as a means of protecting and promoting select domestic industries. Characterized as “industrial policy,” such mechanisms might include subsidies of infant industries, trade tariffs, or the fostering of innovation systems to develop skills and education. Each are aimed at creating comparative advantages in key sectors, leading to economic growth and positive trade outcomes (Di Maio & Valente, 2013:109). Indeed, Cimoli et al. (2006:25) contend Hamilton and List “were and continue to be right that successful catch-up in industries where international trade is considerable requires some kind of infant industry protection or other means of support.” In other words, countries have only successfully industrialized by strategically advancing selected industries.

Industrial policy is defined by (Chang and Amsden, 1994:60) as “a policy aimed at particular industries (and firms as their components) to achieve the outcomes that are perceived by the state to be efficient for the economy as a whole.” Cimoli, Dosi and Stiglitz (2009) articulate these elements as a set of mechanisms including innovation and technology, education and skill-training, trade policies, targeted industrial support measures, sectoral competitiveness politics, and competition regulation policies. Rodrik (2008:18) defines IP more abstractly, as a “process,” ultimately a state “dialog and deliberation with the private sector”. As demonstrated later in this chapter, viewing IP as a process is especially

important to VSI, where the continuous engagement with the private sector underpins successful outcomes.

The theoretical basis for VSI was developed out of the successful and unsuccessful applications of industrial policy. On one hand, it is a product of theoretical learning, and on the other hand the product of industrialization in a globalized world. The following section will outline the theoretical predecessors to VSI.

How VSI Emerged In the Aftermath of ISI and EOI

As described earlier, IP originated out of Europe and the US, as during the latter half of the 19th century these nations restricted trade in order to grow infant industries. By targeting public resources and trade policy to underdeveloped sectors uncompetitive with foreign firms, governments were able to successfully localize manufacturing. After World War II, such techniques were replicated in the Global South as a more intentional strategy of industrialization. Predominately applied in Latin American countries, these policies became known as Import Substitution Industrialization (Baer, 1972). The theoretical basis rested on works of Prebisch (1954) and Singer (1960). The Prebisch-Singer hypothesis stipulated the relative price of primary commodities, such as fruit or minerals, will decline as the price of manufactured goods increases. Thus, states reliant upon exports of primary materials would gradually lose comparative wealth to manufacturing-intensive economies. Import Substitution Industrialization (ISI) was supposed to hedge against this: by overvaluing currency, applying high import tariffs and heavy subsidies on manufacturing, states could purchase expensive capital from foreign companies to create manufacturing sectors of their own.

ISI promoted autarky, or vertical industrial integration. Policy advanced the development of producer driven chains, restricted foreign direct investment and imports, and created regional development policies in order to reduce dependency from industrialized nations. While this pattern of industrialization was common in the early second half of the 20th century, it later was largely disregarded for a number of reasons. First, it undermined the concept of comparative advantage as industrial policy built vertically integrated supply chains. Furthermore, trade tariffs limited ISI countries' demand base, as international markets were difficult to access outside the regional trade agreements. A limited market also slows a firms' ability to reach economies of scale (Baer, 1972). Importing capital cause foreign debt to grow excessively, leading to numerous criticisms of Import-Substitution of Industrialization.

It is worth noting that ISI stands in complete contrast to VSI, as actors in VSI assume trade barriers as both impractical and uneconomic. The failure of ISI helps make the case that countries should specialize in their comparative advantages, harkening back to the original ideas of Ricardo (1817). It also demonstrated that by rejecting free trade principles, developing nations would incur debt and economic inefficiency. Indeed, Export-Oriented Industrialization (EOI) emerged as an alternative form of development proposed by a consensus of economists during the 1970s (Palley, 2011:3). Grounded in the Heckscher-Ohlin theory of comparative advantage, EOI sought to exploit capital-labour ratios, growing domestic productive capacity by using cheap labour to manufacture goods in demand by developed economies. With an eye toward developed economies, states would subsidize exports, and narrowly target credit and foreign direct investment toward specific sectors. By relying on robust trade with the West, buyer-driven chains in East Asia were believed to help control rent-seeking and encourage knowledge spillovers into the domestic economy (Palley, 2011:4). By using these ties to foster innovation systems, state-run firms could ideally move up the supply chain – training workers in assembly, then manufacturing, and ultimately marketing and branding (Grossman & Helpman, 1990).

On the other hand, world systems theory suggests that export-oriented industrialization would lead to dependent enclave economies, as foreign demand-oriented sectors could have few linkages to the domestic market. Furthermore, reliance on developed countries would engender an overdependence on multinational corporations, leave the state without indigenous entrepreneurs. Finally, as demand is concentrated in select markets, export-oriented industrializing economies are more vulnerable to swings in the global market forces (Barrett & Chin, 1987:24). To address these concerns, states must have a proactive role in shaping industrial policy and innovation systems, thus developing skills of the local employment base. It also demands states actively work to move up the supply chain, increasingly targeting sectors that require greater skills. The shortcomings of EOI reveal how IP would ultimately need to stress upgrading and regional market development to foster stable and robust economic outcomes.

The failures of EOI and ISI to accommodate the globalized landscape, and presence of newly industrialized countries- such as China and India- created the theoretical basis for global value chain oriented industrialization. In the era of VSI, policymakers are tasked with creating an environment conducive to industrial upgrading within a value chain. The following section will evaluate how policymakers may be able to achieve this successfully.

2.12 Policy Design and VSI

While this section will later explore the role of multinational firms in the era of VSI, it is also important to outline key steps policymakers may take to facilitate domestic industries' integration and subsequent upgrading within a global value chains. As with EOI and ISI, state governments needed to coordinate consistent and dynamic policies to build manufacturing and subsequently service-oriented sectors. The challenging and multifaceted process in VSI requires critical action from the national and local government. Milberg, Jiang and Gereffi (2013:162) outline six public policies that governments can implement to advance Vertically Specialized Industrialization:

1) *Narrowly Targeted Policies*: Perhaps the most critical aspect of VSI, state industrial policy must focus on specific aspects within the global value chain, rather than try to develop a vertically-integrated industry, which may be inefficient. Policies can regulate certain links to the global economy, such as exchange rates and foreign direct investment, but also cluster key sectors to encourage linkages and spillover effects. As global value chains influence economies on a disaggregated level, the OECD (2011:35) notes that government policies must be "fine-grained" and "targeted more at specific activities." In order to accommodate the rapid volatility of world trade, lawmakers must design policies as flexible to international economic forces.
2) *Institutional Support for Social Upgrading*: This strategy suggests that government must support institutions that build and sustain innovation. Social upgrading not only refers to developing an innovation system among educational institutions, government actors, multinational firms, and aid organizations, but also giving companies the financial tools necessary to invest in innovative activities. This aspect will be explored later as a "technology innovation system" (TIS).
3) *Coordination among Lead and Supplier Firms*: Transnational corporations play a critical role in determining outcomes for local firms. The focus of industrialization is not necessary to create and export new technology, rather moving up an existing value chain through mechanization or skills development. States must engage with lead firms to ensure governance structures are in place to achieve such outcomes. By facilitating partnerships between lead firms and local suppliers, governments can signal a commitment to supporting a favourable business environment for MNCs.
4) *Fostering Cheap Access to International Trade*: Trade policy is crucial for importing intermediates and exporting of processed goods. Greater access to trade may be facilitated through export processing zones (EPZ's), which have been characterized as "vehicles of globalization" (McCallum, 2011:1). These zones make importing and exporting goods less

cumbersome by reducing tariffs and transportation expenses, as well as give firms greater access to skills, equipment and logistics networks by clustering producers (Milberg, Jiang & Gereffi, 2013). However, EPZ's may also weaken the state's ability to pursue upgrading strategies or achieve socio-economic goals for the local workforce (McCallum, 2011).

5) *Promoting Regional Production Networks*: Evoking similar logic to proponents of import Substitution Industrialization, regional or bilateral trade agreements are important for improving the efficiency of the value chain through reducing in transportation costs, cooperating in infrastructure development goals, and serving existing transnational corporation networks. Preferential trade agreements (PTA's) also enable countries to consolidate power among neighbours, providing a political incentive for regional trade coordination.
6) *Place Metrics on Value Add*: Critical for global value chain industrialization, policymakers must quantify the value added from imports. This gives lawmakers and understanding of the economic benefits of each stage of the value chain, and weigh the fiscally responsible means of pursuing further upgrading strategies.

Ultimately, the era of Vertically Specialized Industrialization continues a theoretical debate over neoliberal policy and a new era of industrial policy. Milberg, Jiang and Gereffi (2013:169) acknowledge that "trade policy alone is not an adequate policy to guarantee growth and development," rather, governments must directly support business and skills development as a component of comprehensive industrial policy. Indeed, this implies that governance strategies of firms, in conjunction with supportive public policy, underpin the success

of industrialization in the era of VSI.

This analysis focuses on governance strategies of domestic firms, which can relate to each of the six of challenges outlined by Milberg, Jiang and Gereffi (2013): how are local firms engaging with state policymakers, pursuing innovation policy, and regional market development?

Renewable Energy Industrial Policy in the Context of Global Value Chains

As this thesis places renewable energy manufacturing in the context of vertically specialized industrialization, it is important to examine the relevant literature on "green industrial policy." Energy policy is the cornerstone of industrial policy, as electricity and fuel underpin economic growth (Pegels & Lütkenhorst, 2014:2). However, industrial policies aimed at renewable energy manufacturing are a 21st century phenomena. Thus it is unsurprising Zhang et al (2013) find "no uniform definition of either

renewable energy policy or industrial policy for renewable energy." Nonetheless, Pegels (2014) was able to draw conclusions that policy design in the renewable energy context faces a unique set of barriers: urgency precipitated by the imminent threat of climate change, uncertainty related to technology diversity, a long time horizon as renewable technologies become fully integrated into the electricity grid, and finally, the market failure of not accounting for carbon emissions in the marketplace. Given such challenges, theoretical assumptions from other industries may not apply to the clean technology sector.

Renewable energy industrial policy originated in industrialized economies, such as Germany, Denmark, and United States, as objectives were largely environmental, rather than economic. For example, Lewis and Wiser (2007:2) drew conclusions from the experiences of Western countries that imply an effective process toward building a domestic wind industry. Interestingly, this mimics a pattern of upgrading: the authors note that all components must be first imported in order to create domestic demand for wind power before a manufacturing industry can be established. States should then pursue technology transfer and equally important, local skills development, from foreign firms as an intermediate measure to developing local assembly and manufacturing infrastructure. Technical capacity in similar industries accelerates development, as knowledge spillovers foster easier localization strategies ((Kamp, Smits & Andriesse, 2004). Lewis and Wiser (2007:19) indicate a "gradual, staged approach" to building an industry, adapting policies to meet the local capabilities with the ultimate goal of starting a domestic manufacturer. This not only complements industrialization goals, but ensures component prices are kept low to build stable, growing demand. In this manner, Lewis and Wiser (2007) have implied that the strategy toward building a domestic renewable energy industry- through upgrading, localization, and domestic incentives for growing demand - closely resembles policies that reflect vertically specialized industrialization.

Yet Pegels (2014:15) cautions against relying too heavily on the experiences from other countries, particularly as they are first-movers. She found that while their policy approach should not be replicated, but it should still be treated as a useful tool for learning. It is worth noting, however, both China and India pursued a VSI-based strategy in wind energy since the 1980s. Initially, China imported wind turbines from European manufacturers, and subsequently laid the groundwork for domestic manufacturing capacity through imports of capital and foreign direct investment. As the Chinese economy grew rapidly through the early 2000s, state-owned companies obtained licensing from foreign

firms, and began investing in in-house research and development and design. By the late 2000s, local component manufacturers had entered the market, enabling China to localize a substantial portion of its wind turbine manufacturing. Suzlon, an Indian manufacturing firm, followed a similar path: pursing higher-value production activities until ultimately facilitating research and development in India (Iizuka, Dantas & Freitas, 2015:414).

There could be an opportunity for South Africa to leapfrog across the more traditional pathway taken by China. Lee, Park and Krishnan (2014) note how Indian information technology (IT) firms were able to leapfrog over barriers to growth and compete with incumbent firms by taking advantage of changes in the industry paradigm, such as a disruption in traditional trade practices and technology. In the case of the solar or wind industry, such disruption may be the growth and increasing affordability of off-grid technology, or financial models to make residential solar energy more accessible, could offer opportunities to avoid traditional barriers to upgrading.

That said, there remains limited analysis on how renewable energy fits into industrial policy in developing economies outside the experiences of China, and to a lesser extent, India and Brazil. Given these geographic constraints, the following section will attempt to detail broader theoretical observations of renewable energy manufacturing policy, and how that might relate in the context of South Africa integrating into the broader solar and wind value chain. Each of these components is inherently linked to others, and will be explored directly or indirectly in the discussion.

Initial Technology Transfer

Policymakers have a suite of tools to encourage cross-border clean tech transfer to lay the groundwork for a domestic renewable energy base. Gallagher and Zhang (2013) describe turnkey contracts, equipment trade, foreign direct investment, joint ventures as the most traditional mechanisms. States can use more innovative strategies, such as attracting foreign-educated workers, partnerships with foreign research institutions or shared intellectual property, or even the purchasing of a foreign firm (Gallagher & Zhang 2013:41). The success of technology diffusion is impacted by several factors, including the size of the domestic market, policy certainty, infrastructure, and mobility of the technology and human capital (Gallagher & Zhang 2013:42).

Consistency in Domestic Deployment Policy

Firms require policy certainty that local renewable energy demand will be sufficient before committing resources to establishing a manufacturing base. In this manner, renewable capacity mandates provide a key policy signal to attract foreign manufacturers. Lund (2009:63) concluded that there is a positive correlation between policies that promote deployment and industrial activity, even if the existing industrial base is initially weak. Lewis and Wiser (2007: 1853) found that stable, sizable demand (roughly 200 MW per year for at least three years) for renewable energy in the domestic market is an "essential foundation" for an internationally competitive manufacturing base. Indeed, once an efficient manufacturing base has been established, a positive feedback loop occurs: states can support domestic industry by pushing for greater- and cheaper- renewable capacity. Zhang et al. (2015:4) shows a "natural affinity" between manufacturing and generation policy: as manufacturing reduces component costs, it gives policymakers greater incentive to support domestic installations of renewable energy. In fact, the Chinese government was criticized for engendering a solar energy manufacturing industry without stimulating sufficient local demand (Zhang and He, 2013). Faced with a glut, the industry was forced to lower prices in order to stay economically viable.

In the case of Brazil, the government spurred wind energy deployment through guaranteeing grid access and setting fixed tariffs. It then set a renewable standard mandating 10% of electricity come from renewables, with a competitive bidding system to facilitate contracts (IRENA, 2016).

Thus, cultivating regional markets are necessary to ensuring demand can match supply. In Germany, the strong feed-in tariff measures created high domestic demand, eliminating any opportunities to export wind technology (Pegels & Lütkenhorst, 2014:9).

Local Content Requirements

Localization policies are another critical component for developing a renewable energy manufacturing base. First-mover countries, such as Germany and the Netherlands, had no need for local content requirements as demand often exceeded supply. In order to compete with European manufacturers, the Chinese government offered import tax exemptions to renewable energy components, substantial state financial backing to domestic manufacturers, local content requirements on capacity installations, and R&D support to build local workforce skills to create a domestic industry (Zhang, et. al, 2013:345). The Brazilian government had a different approach. While all companies could participate in the feed-in

tariff program, firms could receive 80% financing from BNDES (the Brazilian Development Bank) at a 0.9% interest rate, if 60% of the weight and value of the material was procured domestically (Rennkamp and Westin, 2013:10-11).

The Global Wind Energy Council (2012) concludes that local content requirements can have a strong desired effect, but only when coupled with stable, long term policy to foster a significant domestic market. LCR's are best ramped up over time in order to build manufacturing capacity while keeping installation costs at a reasonable level.

Robust Dialogue between Industry and Government

Strong political relationships are useful to designing narrowly targeted policies. First, political actors must establish partnerships with lead foreign firms and domestic suppliers in order to ensure proper financing and policy certainty for the broader industry. This was critical for the success of German, Spanish, and Danish wind industries (Mitchell & Connor, 2004). That said, governments must maintain a reasonable level of distance from the business community, demonstrating it does not favour one specific renewable technology industry, and underperformance will lead to a removal of subsidies or preferential tax treatment (Rodrik, 2014).

Special Economic Zones & Industry Clusters

Strategically locating manufacturing and design firms can foster greater access to the global market, support innovation, and attract skilled workers to maximize the strength of a labour pool. The "North Western Region Wind Power Cluster" in Germany has been credited as a "driver of competitive strength" (Pegels & Lütkenhorst, 2014:11) as over 300 manufacturing and supplier firms, governments, and research institutions. It is worth noting however, that a large part of this cluster's success can be attributed to Germany's historic leadership in the engineering and power sectors. Nonetheless, clustering has an important role in innovation and deployment; in the case of Germany it is evident in the wind sector. Pegels and Lütkenhorst (2014:16) also point out photovoltaic technology is not as reliant on innovation hubs to spur deployment, as it is easily transferrable.

Innovation Policy

Altenburg and Pegels (2012) note that innovation pathways in the green industries are country specific, as policy and finance play a strong role at the domestic level. European, Indian and Chinese firms

pursued very different innovation paths: European companies emphasized quality and R&D, China stressed cost innovation and uptake, and India pursued diffusion through the domestic market. That said, Lema & Lema (2016) demonstrate innovation in the wind sector is becoming increasingly globalized, as European and Chinese firms are more interconnected through licensing agreements, acquisitions, and FDI. The synergistic innovation among international firms suggests developing countries can pursue innovation paths specific meeting the needs of rural poor

Gosens, Lu and Coenen (2015: 385) explore this concept in the context of renewable energy by outlining key points of the technology innovation system (TIS) as it relates to clean tech in emerging economies. Emerging economies are heavily influenced by the transnational dimension of the TIS, thus policy mechanisms must balance attracting foreign expertise and capital while building local capacity and know-how. Policies such as firm to firm knowledge exchanges, intellectual property rights protection, work incentives for skilled labour, interaction with domestic universities and research institutes, and finally, a broad, dynamic technology roadmap foster a stronger innovation system to build a domestic renewable energy market.

Soumonni (2013) corroborates this point, suggesting comprehensive technology policy in developing countries includes a number of key elements. Local firms must attain well-designed licensing agreements and spaces for turning renewable innovations into technology, and subsequently usable products, in order to turn products into market. These elements, and their relationship to industrial upgrading, are at the crux of this research. Ultimately, they comprise a firm-level governance strategy that relates to VSI. As explored in the methodology, they will be used as a metrics for determining what ways local renewable energy firms are part of the South African government's strategy to pursue a GVC-oriented industrialization strategy.

2.2 Applying VSI to the South African Wind and Solar Industry

The following section will explore practical applications and challenges to VSI. It will first examine the perspective on the rise of South-South trade, with a particular focus on China. It will subsequently review South Africa's industrialization history, and discuss agreed-upon factors that led to greater integration into global value chains. Finally, it will contextualize the domestic renewable energy industry against a backdrop of the global wind and photovoltaic value chains.

2.21 Industrialization in the 21st Century

Key literature identified present-day challenges for industrialization in the present-day financial and technological global landscape. Shafaeddin (2012:28) found a shrinking policy space for industrialization as the result of several key factors. First, the existence of large, multinational firms, capable of efficient production with great returns

to scale, creates high barriers to entry. Domestic firms require substantial levels of investment to become profitable. Second, there is growing technology gap between industrialized countries and developing countries, leading to longer learning rates for technological adoption. Globalization has created a unique demand for foreign-made luxury items, such as smart phones, thus reducing consumption of goods often produced in developed countries. Finally, in order to compete against these global forces, governments need to provide comprehensive infrastructure and institutional support. Cash-strapped governments, with high interest-rate loans as major sources of income, would find this level of support particularly challenging.

The Role of China- Has the Early Bird Caught the Worm?

Modern industrialization policy literature emphasizes the experience of China, or its present impact on manufacturing. Indeed, China remains the "greatest success story in the era of VSI," (Gereffi & Sturgeon, 2013:163) as it identified and applied upgrading strategies to successfully move into high value activities. Gradual and targeted trade liberalization, in conjunction with structured industrialization strategies, enabled a controlled path toward industrialization. The Chinese government created a robust national innovation system by supporting research and development (R&D) and skills development through collaboration among national universities, the public and private sector, and foreign firms. (Shafaeddin, 2012:37) The People's Republic is not home to four of the ten largest solar manufacturers in the world.

These factors are important for this study as they enabled China to emerge as the first developing economy country with a globally competitive, renewable energy manufacturing base. Sharing similar

goals to South Africa- employment, industrialization, energy diversification- China used a suite of industrial and innovation policies to foster wind and solar manufacturing sectors. First, by securing licensing agreements and joint-partnerships with Western firms, the industry established domestic innovation capacity. Some local firms tapped the design expertise of European and American firms as well. Strong inter-firm relationships, in addition to investments in local innovations and firm-level learning, were key to moving China's capacity from strictly production to innovation (Schmitz & Lema, 2015:112). It is important to note that China allocated a tremendous level of stimulus- 5.3% of GDP- to green industries to jumpstart this bold initiative.

China's meteoric rise in the sector may provide a model for South Africa to do the same, but poses both challenges and opportunities in a practical sense. On one hand, its dominance in the sector could undermine efforts by South African firms to achieve similar success. China can compete with local producers, squelching entrepreneurship opportunities, infant industries or other businesses that manufacture products manufactured with cheap labour (Kaplinsky & Morris, 2008:3). For example, South African clothing and furniture industries have struggled to compete with Chinese industries, in both domestic and global marketplaces (Nurse, 2012:58). On the other hand, the rapid ascension of China can spur South African development. Chinese firms can provide South African solar firms with technology transfer, skills development or joint-partnerships that could mutually benefit both countries. Already, the export of South African commodities directly or indirectly support the Chinese solar industry.

Looking beyond the West

Indeed, there is evidence of similar relationships evolving across emerging markets. South-South trade has greatly increased in the recent decade, revealing the importance of demand from developing nations (Milberg, Jiang & Freitas, 2013). This is especially notable in the wind and solar industry. As rural electrification, off-grid technology, and energy access initiatives grow throughout the region, the demand for solar and wind manufacturing should also rise. This inevitably means a wider scope of opportunity for South African renewable energy manufacturing firms. On the other hand, other developing countries may use their comparative advantages- such as cheap labour- to enter the market and compete within the global value chain.

As explored in the subsequent section, South Africa has had a unique pattern of industrialization. By

exploring its history, one can understand how it may be uniquely positioned to harness the opportunities of the solar and wind value chain.

2.22 South African Industrial Policy

As the most industrialized country south of the Sahara, South Africa faces unique challenges within the broader context of African development. Historically, the country's industrial policy was tied to its rich mineral resources, institution of cheap labour, and socioeconomically-stratified economy. The democratic transition marked a new era for industrial policy, with an eye toward global markets and reducing inequality. The following sections will explore these dynamics, and how they ultimately relate to the wind and solar manufacturing industry.

The Minerals Energy Complex

South African industrial policy was founded upon minerals extraction and shaped by import substitution industrialization in the era of apartheid policy. Fine and Rostomjee (1996) coined the term "minerals-energy complex" (MEC) to denote a central tenant of South African political economy. The MEC holds that South Africa's coal and mining sectors, in combination with exploitatively cheap labour, has built the country's wealth. As a result it underpins its political economy, creating a *de facto* industrial policy matching the coal and mining sectors' interests. The government tailored public infrastructure and social policy toward the continued growth of a vibrant minerals industry powered by cheap coal. The MEC resulted in a unique power dynamic, which crowded out other industries, such as light manufacturing or textiles. The strong presence of the fossil fuel industry crowded out other energy sectors, as it may consider solar and wind as disruptive (Baker, 2015).

The apartheid regime fostered an environment based on low-skill, low wage labour supporting the interests of the white elite. Economic sanctions pushed the country into adopting an import substitution model of industrialization, manufacturing products that could be purchased more cheaply from abroad. These industries were based on the consumption patterns of the moneyed elite, rather than broader swath of society (Chang, 1998). Ultimately, this model was unsustainable, both socially and economically, and was replaced during the dismantling of apartheid (UNECA, 2014:50).

The Democratic Transition

The democratic transition initiated a new direction of industrial policy. Domestic policy targeted disenfranchised populations: prioritizing job creation for previously disadvantaged citizens, expanding public housing and electricity access, and transforming the production base toward the needs of the broader South African society. There was a shift from industrial policy driven by mineral exporters and mining companies to the manufacturing sector and economic diversification (Morris & Martin, 2015). Trade also experienced a rapid shift: no longer burdened by sanctions, the new government embraced liberalization as a means of economic opportunity. In fact, the average industrial tariff fell from 28% in 1990 to 8.2% in 2006 (Zalk, 2014:337) Twenty-seven bilateral trade agreements were signed in the five years following 1994, Foreign Direct Investment (FDI) stocks grew 537% through 2004 (Economic Policy Forum [EPF], 2015:74). No longer protected by import tariffs, domestic firms had to compete on a global scale.

Concerns arose that liberalization undermined local businesses. As a hedge, the government implemented strategic supply-side policy initiatives aimed at nurturing key industries believed to be competitive in the global economy (Chang, 1998). Such supply-side measures included mining, automobiles, textiles, and clothing industries, with a much broader focus on manufacturing growth and small-to-medium enterprise (SME) development (Altman & Mayer, 2003).

Minerals beneficiation was one of the primary targets for industrial upgrading. Given the linkages already established by the MEC, it was a natural fit for industrial policy initiatives. Indeed the wake of strong policy support between 1994 and 2011, the minerals beneficiation sector was able to generate employment at a higher rate than other sectors (Zalk, 2014). Unlike other African nations, South Africa avoided becoming an enclave economy by enabling the mining sector with extensive forward linkages: processing ore and soft industrial commodities (Morris, Kaplinsky & Kaplan, 2012: 94).

The targeting of automobile and clothing industries yielded important results. Initiatives, such as the Motor Industry Development Program and Clothing Textiles Competitiveness Program, enabled manufacturers to receive credit by investing in upgrading activities (Zalk, 2014). The sectors initially received import rebate credits for components not produced in South Africa. This enabled them to use foreign technology to build up capital that would keep them competitive. The automobile sector is often cited as a successful example of South African industrial policy. Mohamed (2012a) notes that it was not coincidental that it was only manufacturing sector that saw growth in capital stock at the turn of the

century). In addition, it generated spillover effects to other sectors of the economy (EPF, 2015:87). Similarly, the clothing sector was able to stabilize its employment rate despite facing major competition from Asia.

However, no formal industrial policy was pursued over the course of this period. The government was focused more on trade liberalization, controlling inflation and maintaining low budget deficits. These priorities served as a means of attracting foreign investment and credibility abroad (Mohamed, 2012b:257). FDI targeted existing industries with little job creation potential; greenfield investments were relatively low (EPF, 2015:77).

The Global Recession and a Need for Industrial Policy

Mohamed characterizes such decisions to liberal trade and maintain low budget deficits as "disastrous;" uncontrolled capital flows resulted in volatility, speculation, and debt-driven consumption (2012b:274). Commodity exports continued to fuel economic growth; Zalk (2014) found that South Africa experienced its own "Dutch Disease" as a result. Rodrik (2008) noted a "tension" between monetary policy and the tradables sector, finding an appreciated currency as a result of inflation targeting. This was exacerbated during a commodities boom (Rodrik, 2008:36). Agricultural and mining employment had been falling for three decades, and manufacturing jobs were not growing to balance out the impact (Rodrik, 2008:6). As a consequence, even before the global recession of 2008, South Africa was plagued by a period de-industrialization, market volatility, and high unemployment.

To reverse these trends, industrial policy became necessary. In 2007, the Cabinet approved the National Industrial Policy Framework, which called for diversification, growth in industries with export potential, labour-absorbing industrialization that favoured historically disadvantaged populations.The DTI (2011:29) called for a number of tools to be used, including coordination between macroeconomic and industrial policy, industrial financing initiatives, leveraging of public and private procurement to boost domestic production, trade policy, and innovation policy tied to sectoral priorities. Calitz, Wallace and Burrows (2013) estimated that 94% of investment incentive spending was targeted at the manufacturing sector.

South Africa's Integration in Global Value Chains

The changes in the latter half of the 2000s signalled how South Africa's industrial policy was informed by emerging schools in global value chain analysis. Tariff policy was no longer unidirectional, instead it

focused on strategic sector priorities. Tariffs in sectors with high value add were increased, whereas sectors with existing domestic market power were lowered or eliminated (Zalk, 2014). As tariffs on intermediates fell, the IPAP ensured financing for supply-side upgrading and skills development.

The Special Economic Zones Bill of 2012 spurred the expansion of industrial development zones to relieve import duties, increase access to global markets, offer preferential tax incentives and encourage joint innovation through shared infrastructure. Some have claimed SEZ efforts have thus far been "a failure," as policies were neither strong enough to yield substantive results, nor carefully coordinated with local and national governments (McCallum, 2011; EPF, 2015: 87;).

The African Development Bank noted selected South African industries are integrated into global value chains, particularly in mining, automobiles, agriculture, and finance sectors. As an African nation, it had a unique ability to do so due to scale and efficiency (AfDB, 2014. World Bank Group (2016) concluded the country shows "moderate levels of GVC participation," (v) consisting mainly of commodities or end products. Export of intermediates in other sectors is relatively low compared to other developing nations.

At present, the average South African export contains 16% of foreign value add, higher than India, Russia or Brazil (AfDB, 2014:57). Mining and automobiles are among the strongest sectors, accounting for a quarter of GDP. The historical strength of the South Africa mining sector makes an obvious case for its major role on a global scale. The automotive sector's integration into GVCs, on the other hand, was perhaps the result of an "explicit GVC policy" implemented in 1995 (AfDB, 2014:57). With skilled workers in the industry, the nation serves as an assembly hub and component manufacturer for foreign firms. The average share of South African value add to an exported vehicle is 35%, with the share going as high as 75% for select components (OECD, 2014). However, opportunities to move into branding or design are limited, as lead firms continue to maintain control. Hence, South African may be caught in the middle-income country valley, with little opportunity to pursue higher value opportunities.

South Africa's Role as a Regional Hub

Milberg, Jiang and Gereffi (2013:167) substantiate that the regional integration is the basis for industrial upgrading in South Africa. South Africa provides access to the sub-Saharan market and substantial trade with the rest of the world. The country unequivocally serves as Southern Africa's 'headquarter economy;' it consists of 63% of SADC's GDP and provides neighbouring nations with exports and market opportunities. In fact, the Economic Policy Forum (2015) found a tendency of foreign firms to set up in

South Africa before expanding into the region. Indeed, from 1995 to 2011, the use of intermediates from neighbouring countries rose nine-fold, meanwhile South African intermediates embedded in exports in the same countries increased fivefold (AfDB, 2014:28). The automotive industry provides an example of neighbouring countries integrated into a regional value chain: wiring and batteries now produced in Botswana support automobiles manufactured in South Africa (EPF, 2015:95). The regional hub role of South Africa could be compared to China's role in East Asia in the 1990s (World Bank, 2016:80).

The vast majority of South African manufactured goods remain in Africa. Retail, such as Shoprite, or telecommunications firms, like Telkom, have expanded into regional markets (AfDB, 2014: 60). South Africa is a "critical regional node," a gateway for the region containing transport and trade infrastructure to support neighbouring nations (World Bank, 2016: 6). Furthermore, infrastructure in Botswana, Angola or Zambia is tailored toward natural resource extraction, thus only South African companies have the potential to drive [regional value chains]" in the manufacturing and services industries (World Bank, 2016:79).

Moving Forward: The Pursuit of Upgrading

The World Bank (2016:5) notes that for "South Africa in particular, joining GVCs is not enough; [it] must establish value-adding positions in these production networks, and upgrade continuously if they are to use GVCs effectively as an instrument for inclusive growth." As noted earlier, South Africa has deployed effective upgrading strategies in the automobile, agriculture and pharmaceutical industries. Mineral processing is another example: originally raw materials were shipped to China for processing. As part of the government's efforts to increase upgrading, processing now takes place domestically before export to China (Milberg, Jiang and Gereffi, 2013:166).

Yet barriers to upgrading remain. Cheap access to international trade is challenging because of high transportation costs. For example, the cost to export a twenty foot shipping container is more than triple that of China. In addition, the average export time lags far behind that in Latin America, Europe, or Asia (AfDB, 2014:48). Within the SACU region, trade and transport infrastructure needs significant improvement: barriers to cross-border trade are high, and factor mobility is limited (World Bank, 2015:vii).

Finally, South African firms have cited a lack of skills needed for long term growth, indicating that innovation policies have not given sufficient attention to global value chain integration (AfDB, 2014:62).

The AfDB (2014:62) notes that skills development policy, particularly tailored toward industries with strong linkages to other parts of the economy, are essential should South Africa wish to continue growing on a global scale.

This point is especially relevant to the renewable energy industry. South Africa does not have a large skilled labour pool related to the wind and solar industry, a shortcoming for innovation in the sector. In Germany, for instance, 70% of employees in the wind and PV industries completed vocational training, with just 15% completing none at all (Pegels & Lütkenhorst, 2014:19). This highlights how South Africa must first focus on lower-skill opportunities in the sector before moving on to higher value add roles.

The Renewable Energy Manufacturing Industry in South Africa

There is a strong case that renewable energy is perceived as part of upgrading, innovation, and industrialization strategies of South Africa. Zalk (2014:39) noted that solar and wind were identified as opportunities in "part of production chain rather than importers," as "procurement and supply-side upgrading are the critical instruments to participate as component suppliers" to the wind and solar industries. What remains unclear is whether empirically this is the case.

By the early 2010s a wave of consolidation had marked the global wind and solar industries (Eberhard, Leigland & Kolker, 2014). Technology overcapacity incentivized Chinese and European firms to identify new markets to sell solar panels and wind turbines. Seizing this opportunity, South African installers and foreign subsidiaries were able to import renewable technology when hardware prices were low. This made a stronger economic case for the RE-IPPPP, as policymakers surmised prices for solar and wind equipment would only decline in the long term.

The RE-IPPPP stipulated rising local content requirements on each round of bidding, thus foreign firms had an incentive to open doors in South Africa. As the first of RE-IPPPP bids were awarded in December of 2011, the utility-scale solar and wind manufacturing capacity of South Africa is new. Hence, the literature examining the industry is limited to a small number of recent studies and industry publications.

Iizuka, Dantas and Freitas (2015) noted that the build-up of utility scale wind turbine manufacturing capacity has been "minimal," as turbines were imported to meet the capacity installations under the RE-IPPPP. A DTI (2015:92) report noted that as small to medium size turbines maintain a viable market, the industry may serve as a stepping stone to utility scale sector. Yet at present, utility size manufacturing capacity remains at its "infancy". Two companies, both subsidiaries of foreign firms, manufacture

towers, while there is no blade manufacturing or nacelle assembly in South Africa. The DTI (2015:116) report cited key barriers to blade and nacelle manufacturing sectors: lack of adequate capital, insufficient skills in the workforce, and concerns on the long term viability of a market. It has been suggested that the IRP 2010 alone, which calls for 8.4 GW of wind generation capacity, is insufficient to create enough demand to justify the capital costs of more than one new blade or nacelle manufacturing facility (DTI, 2015). Industry representatives in the domestic market have suggest that increasing the local content requirements in the RE-IPPPP would be challenging, unless there are significant manufacturing incentives to spur the presence of new suppliers from abroad (DTI, 2015:xx).

Similarly, solar module manufacturing capacity is limited, with two foreign subsidiary firms and one local firms in 2016 producing panels. This can be attributed to the fragmented nature of capacity additions: companies competing in the RE-IPPPP will not invest in manufacturing until they have been awarded bids. Hence, foreign firms have not been able to make significant, long term commitments to stimulate local manufacturing (Morris & Martin, 2015:65). It is worth testing this observation in the framework of VSI to determine if the governance strategies of the firms reveal a lack of upgrading, innovation and regional market development strategy.

2.23 Governance Strategies & Renewable Energy Firms

The current literature does not extensively cover the long term strategies of foreign renewable energy manufacturing firms. Carwell (2013:322) describes proposals by foreign solar manufacturers as technology import, not transfer, as they are protective of their role in the global market. German and American firms may grant “very little leeway” for capacity building in other countries, offering little limited skills transfer (Carwell, 2013:323). At the same time, South African inventions have struggled to be produced domestically, as one observer encountered an “inadequate institutional and legal framework, insufficient financing, and lack of specialized solar PV manufacturing capability” to bring his product to market (Perrot, 2012).

As for the wind industry, increased global competition beginning in 2012 (as demand declined) created new trends in the industry. Once highly vertically-integrated companies were forced to rely on ensuring component commonality and strategic outsourcing for select activities where they may not have a competitive advantage (Department of Trade and Industry (DTI), 2015). Key components and final assembly remained in control of the OEMs, while the majority of components are outsourced to specialized manufacturers. This enables flexibility in a turbulent market. Manufacture of blades and

towers were typically localized, however, as their weight and size makes transportation costly. Yet the disintegration of the wind industry makes the case for local suppliers to upgrade into the global wind energy chain.

It worth noting while blade manufacturers do not exist in South Africa, there are firms- such as helicopter blade manufacturers- that have the capacity to pursue blade manufacturing. Yet the companies have cited that the market is currently too small (DTI, 2015). Any factory would have to enable a build-to-design model in order to accommodate a diversity of designs from multiple OEMs (DTI, 2015). As for nacelles (the most expensive part of the project) some OEMs will assemble components sourced from many suppliers with linkages to other industries, such as bearings or gearboxes. This structure does not yet exist in South Africa, and likely may not unless output should exceed 100 units per year (DTI, 2015:. The DTI (2015) also notes that sharing of certain suppliers- such as concrete for turbine foundations- is common among multinational wind manufacturing firms.

However, upgrading and innovation would be critical should the South African renewable energy industry aims to generate broader economic benefits. As South Africa's renewable energy manufacturing base grows, it is critical to have literature informing policymakers of the needs of the renewable energy value chain. In a study of the political economy of South Africa's energy transition, Power et al (2016:18) noted research on the topic "highlights the importance of tracking energy global value chains and production networks where rising power companies are bound up in wider transitional networks" of renewable technology industries.

2.24 Reviewing Major Gaps in the Literature

This literature review revealed three particular gaps that this analysis will attempt to fill. The first gap is empirical: there is limited research reviewing firm-level trends within the South African renewable energy manufacturing industry. Most literature on the South African renewable energy industry focuses on deployment. Localization and manufacturing policy is typically not the primary aspect of the RE-IPPPP studied by researchers, perhaps a result of the quick emergence of manufacturing firms, limited number of case studies, or disinterest from other countries to emulate the localization component of the program. Thus, the first goal of the research is to fill this gap provide a summary of the South African solar and wind energy manufacturing value chain.

The subsequent research gaps specifically relate to the application of vertically specialized industrialization. First, there is a scarcity of analysis applying the theoretical framework of Vertically

Specialized Industrialization to South Africa. In their seminal article detailing the modern application of VSI, Milberg, Jiang, and Gereffi (2013) briefly discuss how the South African government applied VSI strategies through regional integration and trade agreements. Upgrading is mentioned only once as it related to three domestic industries: minerals processing, agriculture and pharmaceuticals (Milberg, Jiang & Gereffi, 167). While VSI-specific literature applying to South Africa is otherwise absent, industrial upgrading in South Africa has been studied with respect to the automobile and telecommunication industries (Lorentzen & Barnes, 2004; AfDB, 2014). That said, there are no in-depth studies in South Africa that apply vertically specialized industrialization as a theoretical framework for analysis. Given the DTI's intention to pursue upgrading and regional market development strategies in many industries, it is necessary to study a South African manufacturing sector through the VSI context.

The third gap in literature pertains to the application of VSI in the renewable energy sector. Green industrial policy is a relatively new body of research, growing in the tandem with the sector rapidly at the turn of the century. While research from the EU and US sheds light on the unique combination of barriers renewable energy faces--including climate policy uncertainty, technology variability, grid integration, the market failure to account for the social cost—it does not use developing countries as areas of study (Pegels, 2014). China is a pertinent case of a developing country successfully nurturing a renewable energy manufacturing sector through innovation and upgrading strategies outlined by Shafaeddin (2012). However, China's first-mover role alters the landscape for other countries doing the same: developing economies must compete with China's technical capacity in addition to cheap labour. Thus it is both critical and novel to apply a GVC analysis to the renewable energy industry in another developing country against the backdrop of China.

Thus, it is necessary to first analyse the renewable energy manufacturing value chain in South Africa, and map out current producers according to the framework established by IRENA and the DTI. Then, interviews with these firms should reveal their long term goals for production in South Africa, and overall engagement with the local innovation system. This will shed light on the ability of South Africa to integrate into the global renewable energy value chain, and potential to attain to higher value-added activities through upgrading.

3. Methodology

As demonstrated in the literature review, the South African government is pursuing a strategy to help local firms integrate into global value chains and ultimately upgrade into higher value activities. Public policies in both the energy and industrial sectors indicate the government seeks to include renewable energy in this broader strategy. This research examines these efforts through the lens of vertically specialized industrialization, deploying a bottom-up approach to assess in what ways South African solar and wind manufacturing firms are pursuing upgrading and regional market development.

Milberg

3.1 Research Design: Qualitative Data Collection

The literature review revealed a lack of firm-level data related to innovation and upgrading within renewable energy manufacturing firms. As indicated in earlier chapters, this may be the result of several factors, including the novelty and dynamism of the market, limited public resources devoted to studying the industry, or difficulty engaging foreign firms to disclose information.

The first step in addressing this problem was identifying and determining how many companies should consist in the data set. This process required identifying companies presently manufacturing major solar photovoltaic and wind components in South Africa. The scoping exercise was performed by evaluating publically available reports, studies, and news articles that relate to the industry as a whole. Once firms were identified, the researcher had an outline of the local market and value chain.

It is worth noting that other forms of renewable energy, such as biomass, solar thermal, concentrated solar power, are being deployed in South Africa. These forms of energy generation were not studied as they are not being deployed to the extent of solar photovoltaic and wind generation. For instance, biomass and concentrated solar power make up 42 MW and 600 MW of the first four rounds of the RE-IPPPP, compared with solar at 2,292 MW and wind at 3,357 MW. Furthermore, multinational companies do not have great of an incentive to localize manufacturing and develop an industry. Finally, global biomass, solar thermal and CSP industries are less mature, thus the theoretical framework of VSI may not apply to those sectors. Hence, just solar and wind manufacturing businesses were studied.

A global value chain analysis was performed on the solar and wind industry. GVC analysis can take place top-down or bottom-up, and given the lack of publicly available data on the local industry, an *industrialist* approach was the most appropriate tool to shed light on how domestic firms are pursuing upgrading. A bottom-up approach required firm-level data on governance strategies to assess the role the industry plays in broader industrialization goals. Morrison, Pietrobelli and Rabellotti (2008:51) note that this lack of insight into innovation in developing countries may be addressing by conducting direct interviews with local firms). Indeed, Lorentzen and Barnes (2004) were able to study upgrading in the South African automotive industry through the conduct of firm-level interviews, with questions relating to innovation and regional development. Hence, the research used this strategy to execute a "bottom-up" global value chain analysis, understanding how firm-level governance strategies related to VSI.

Interviews were designed to provide insight to the core research question: what are the main governance strategies of local renewable energy firms related to upgrading and regional market development? The questions and structure of the interview were informed by the literature review, such that the researcher could reference specific policies or the state of the market. Earlier, the author indicated the key signals of VSI that might apply in the context of renewable energy manufacturing. These elements included initial technology transfer from foreign companies to local firms, development in tandem with domestic deployment policy, adherence to local content requirements, continuous engagement with policymakers, use of industrial clusters and special economic zones, regional market development, and ultimately, a clear innovation policy. Thus, the goal of each interview was to assess the strength of these elements in the larger governance strategy of the firm.

3.2 Procedure for Data Analysis

These elements acted as test variables for the governance strategies of each firm. Hence, a firm with a governance strategy closely aligned with VSI would have hold joint licensing agreements with foreign companies, hold long term plans to meet demands of the local renewable market and upgrade in tandem with strengthening local content requirements. Furthermore, firm leaders would be engaged in market and workforce development strategy with policymakers, participate in efforts to build a green industrial cluster, and focus on emerging opportunities in the region. Most importantly, the firm would have a clear innovation policy to improve efficiency and value of the product.

Clarifying a company innovation policy was particularly important, as it is more conceptual to the other factors. In order to define innovation policy, the author used Gosens, Lu and Coenen (2015)

characterization of a technology innovation system (TIS). A TIS is created by firm knowledge exchanges, incentives for skilled labour, interaction with domestic universities and research institutes, and finally, a broad, dynamic technology roadmap foster a stronger innovation system to build a domestic renewable energy market (Gosens, Lu and Coenen, 2015 Thus, interview questions related to each of these elements to gain an idea of innovation that was taking place on a domestic level.

Finally, the interview questions related to regional market penetration discuss international opportunities. As the development of regional demand is a critical step in VSI, senior staff were asked about the firm's activities in neighbouring countries and plans to enter into distributed generation and utility-scale energy markets. This set of questions also shed insight on the attention of the business leaders to the domestic versus international market for solar and wind components.

It is also worth noting that interviews differentiated between sectors as the manufacturing and assembly process of wind and solar panels is considerably different. Questions related to labour and capital- important in the context of VSI- apply differently in the interviews. Hence, follow up questions were appropriately tailored to each industry. For example, wind turbines contain roughly 8,000 components from 1,000 suppliers, which include the blades, gearboxes, nacelles, generators and foundation. This means the supply chain is long and diverse, requiring a number of partners with several linkages to other mechanical manufacturing industries. Upgrading in the wind energy supply chain is inter-chain upgrading, or expanding into other products. On the other hand, solar panel manufacturing is more linear. The shorter supply chain is generally completed in five major steps, hence product upgrading might be a greater focus (Nahm & Steinfeld, 2014:291). In this manner, interviews differentiated upgrading strategies between the two sectors. Subsequently, analysis was divided by sector to reflect these key differences.

3.3 Data Collection Process

In order to begin addressing the research question, the author needed to perform a high-level form of analysis in order to situate South African renewable energy firms along the broader value chain. The author applied the estimates of solar and wind value-add based off information from the International Renewable Energy Agency (IRENA) By placing each solar and wind manufacturing firm along this value chain, one is able to assess the degree of skills within the local industry, and subsequently examine the relationship to these firms to foreign parent companies, suppliers, or partners. As Figure (1) demonstrates, the value-add of wind manufacturing is varied across the supply chain, implying that no

particular component provides the greatest opportunity for value-add. At the same time, Figure (2) reveals that the crystalline module is plurality of value derived from solar components. This high-level global value chain assessment of the local industry provides a springboard to analysing the upgrading opportunities and potential areas of development. It also helped inform the author of each company's history before direct outreach was conducted to senior staff.

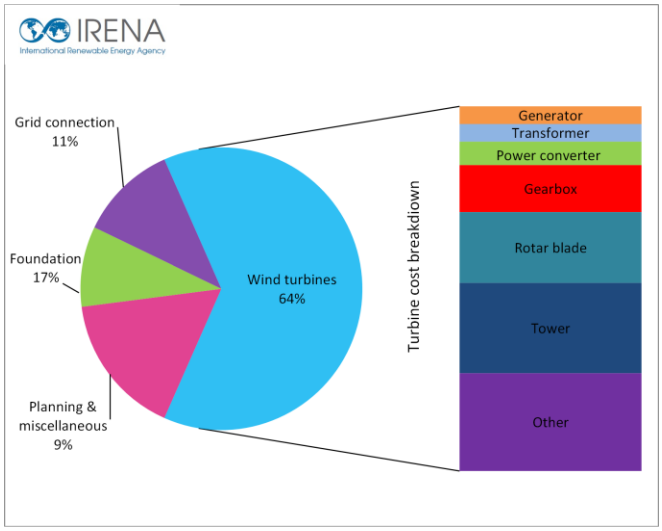
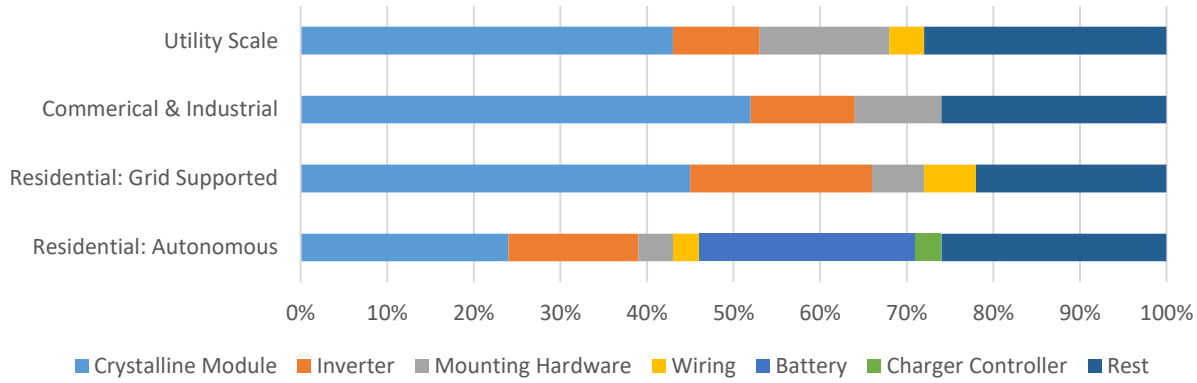


Figure 1 Average cost breakdown of an onshore wind turbine (IRENA, 2014)

Figure 2 Average cost breakdown of PV systems (Ahlfeldt, 2013)



The second component of data collection began by performing outreach to all major solar and wind manufacturing firms in South Africa. The author determined senior staff members, such as CEOs or company sales directors, were targeted for interviews as they would a clear idea of the company's long term priorities in the region. Outreach was performed both through email and telephone. To protect companies, ensure privacy, and maximize information gleaned from the interview, confidentiality and anonymity was preserved. The interview format was semi-structured, in order for the questions to match the history of the company. This was especially important for the companies that formerly held manufacturing operations but since ceased or were awaiting changes in the market.

The goals of each interview was to supplement the literature review and identify the factors that drove each business to South Africa, the skills underpinning growth and development, and engagement with policymakers and the local innovation system. Subsequently, business leaders were asked about the regional market opportunities and plans to expand operations into nearby countries. The piecemeal process of engaging each firm can paint a larger picture of the industry, shedding light on a small component of the broader industrialization strategy of South Africa.

3.4 Limitations to the Study

There are several limitations to this study that are worth noting. The interviews were all conducted by phone or through email, which may lead to interviewees less inclined to discuss matters openly or in-depth (Novick, 2008). Alternatively, the absence of visual reaction from the interviewer may help eliminate bias from a response. It is also worth noting that the interviewer is American, and phoning via Skype. A foreign accent, combined with an occasional poor connection, may cause respondents to doubt that the interviewer is student from a national university. Finally, and perhaps most importantly, the nature of the questions might lead to sensitive information, thus businesses could be hesitant to discuss future development plans openly, and over the phone. Had this research been conducted by a source with existing relationships with companies, he or she may have been able to glean more information that otherwise was kept confidential.

The response rate also limited the strength of the study. Approximately half of companies identified were ultimately interviewed. Some firms explicitly declined requests, others simply ignored it. Despite these setbacks, some of the companies interviewed discussed broader industry observations outside their company, which helped paint a larger perspective for the author. The similarities in observations and responses among the participants also helped mitigated this concern. The semi-structured interview methodology enabled set of responses consistent to the four themes described earlier, but enough flexibility to glean additional insight from participants who alluded to other relevant aspects of the industry. Most interviewees responded to all of the questions; however, some sets did not apply given the stage of production; i.e. firms that had stopped manufacturing operations because of low demand were not planning on upgrading in the near future. Interviews could last between ten and forty-five minutes. All participants were informed their responses would remain anonymous, and their

participation in the study confidential. Summaries of responses were shared with no one aside from the author's supervisor.

Firms shared similar perspectives on governance strategies within the industry, and these perspectives were corroborated with industry observers, leading the author to believe that the interviews reflected the universe of cases rather well. That said, there may be self-selecting bias inherent in the study. The choice to accept an interview may have directly related to the long term goals of the company. For example, a company with private plans to expand into a new product or market may not wish to discuss development strategy with a researcher out of fear of competition. Similarly, larger companies may be more inclined to accept the interview as their market influence and relationship with policymakers is already quite public.

While these limitations may impact the overall conclusions from the study, in general, the author felt the data collection process was robust and sufficient to answer the research question and address the three main gaps outlined in the literature review.

4. Results and Analysis

The following chapter restates the research question, presents the data analysis and summarizes major findings. It proceeds to analyse these results by sector and governance strategy. It concludes by confirming the larger points established by the literature review.

The purpose of the study is to determine what ways renewable energy manufacturing firms in South Africa are maintaining governance strategies associated with Vertically Specialized Industrialization. In the context of VSI, intermediate inputs play a key role to advance industrialization. As South African firms were importing solar and wind technology for assembly, manufacturing, and installation, it led the researcher to further examine how firms are emulating other strategies associated with VSI. The research tested the level of upgrading, innovation, skills development, regional market development and trade to determine evidence of these strategies. The findings are broken down by sector to provide greater detail to the nuances of each industry.

4.1 Key Findings: Wind Energy

Understanding the South African Wind Value Chain

While production of a wind turbine requires approximately 8,000 parts, for the purposes of the study the author focuses on major components, towers and blades. Component manufacturers- businesses that produce concrete foundations, bolts, gearboxes, etc. - maintain a strong presence in South Africa. It is worth noting these suppliers will manufacture products for several other industries as well. Component manufacturers rely on both skilled and unskilled labour, the ratio depending upon the type of product. This portion of the industry is less reliant upon the renewable energy market, although some cited difficulty retaining workers after the wind market experienced volatility. There are just two tower manufacturers in South Africa, and no company manufactures blades.

Innovation in Wind Manufacturing Firms

Innovation in the South African wind industry was scarce at the utility scale level. First, as the RE-IPPPP supressed demand, any innovation was concentrated on determining new markets or products that keep the company in business. One firm noted that Eskom threw current production “into a frenzy” when the utility announced it was no longer accepting bids from renewable energy projects. Thus, the

firm has focused on “keeping their head above water” to avoid shutting down operations. Another company noted that while they had successfully imported the knowledge and capital to produce components independently, they saw no reason to further innovate beyond current operations. Without a market signal that demand will increase, the leadership determined the company should focus on other endeavours. Innovation in the distributed wind sector was centred on mechanisms to streamline operations and build the domestic market. As high value activities were already localised, the firm was focusing on improving the efficiency of production and advocating for public policies might yield increase in demand. In sum, innovation in the wind sector was limited in all firms that relied on the RE-IPPPP for clientele.

Upgrading Strategies of Wind Manufacturing Firms

Weighing the key findings with the literature review reveals that firms largely are not pursuing upgrading strategies consistent with VSI. While the DTI set clear intentions for localization of manufacturing at several aspects of the wind energy manufacturing chain, there does not appear to be sufficient initiative from the private sector to follow suit. As stated earlier, this is primarily the result of weak demand and policy uncertainty. It is worth noting other industries in South Africa, such as the automobile or agriculture sector, were able to successfully pursue upgrading as demand was strong or stable (Altman & Mayer, 2003).

Utility scale wind manufacturers noted that they opened operations as a result of the RE-IPPPP, and remain reliant upon the program’s success to continue earning revenue. Given Eskom’s recent wavering on accepting bids from Round 4, manufacturers have little inclination to move into other lines of production. One firm pointed out that the utility’s reluctance is one of the reasons there is no blade manufacturer in South Africa, despite the DTI’s (2015:xvii) note that the country has the “skills, expertise, capability for manufacture of other operations.” Indeed, tower firms did not indicate intentions to move into blade production. Even if the government were to achieve its goal of 8.4 GW of wind capacity stipulated by the RE-IPPPP, this quantity still may not be cost effective for a blade manufacturer to open operations. There to be little appetite among firms for product upgrading into this space.

Without demand, there is little room for upgrading, unless a company is able to engage in inter-chain upgrading. From the perspective of a tower manufacturer, these opportunities were limited. Component manufacturers have greater flexibility, but lose the training of their staff to other jobs, as

noted in one of the interviews. In this manner, market demand has stymied upgrading strategies in the South Africa wind industry.

At present, initiatives toward upgrading, if any, are centred on process upgrading. Despite its advantage of location, local wind manufacturers found it difficult to compete against the production efficiency of foreign firms. This prompted one manufacturer to mention competition against European firms were a critical reason for focusing on streamlining costs. Should demand increase, these firms could experience increasing returns on revenue as a result of increasing economies of scale.

The role of small and medium sized wind does yet not appear to serve as a "stepping stone" into utility scale production, as alluded to by the Department of Trade and Industry in the Wind Atlas of South Africa report of 2015. This study found no immediate plans to engage in product upgrading in the sector, rather the sector was focused on accessing new markets or advocating for stronger policy incentives. The fact one small wind manufacturer was able to source over 80% of its final product domestically indicates the sector is in line with the DTI's goals of localization.

Skills Development of Wind Manufacturing Firms

Tower manufacturers also contain a variety of semi-skilled and skilled labour, including welders, electricians, and boiler makers. Similar to the tower manufacturer, a small turbine manufacturer reported relying on a range of different skill sets: electricians, mechanics, and technicians, while other employees do not require education beyond Grade 12. In this manner, skills development is critical at every stage of production in the wind the industry. As evidenced by the interviews, companies are investing in technical and engineering skills in conjunction with public institutions.

There is a robust dialogue among educational institutions, wind energy component firms, and government actors to build skills in the wind industry. One industry expert noted reverse trade missions, training programs, and other initiatives demonstrate public commitment to develop local workers' ability to efficiently develop and deploy wind turbines. The firm indicated that workforce development is a boon to the operations of the company, and provides additional incentive to advance operations in the country. The wind industry's linkages to other sectors, such as the automobile sector, were cited as helpful to attracting a staff familiar with certain mechanical operations. Yet two firms cautioned the role of skills development: if a worker has been trained, yet lacks consistent work at the company, he or she will leave for more lucrative opportunities. Thus, wind companies that had made investments in human capital could lose them should there be a decrease in demand. An erratic market, coupled with high

demand for skilled labour, diminished the incentives of wind companies to invest in workforce development.

Regional Market Penetration Strategies of Wind Manufacturing Firms

A wind localization study (DTI, 2015) projected Sub-Saharan Africa to install 12.5 GW of wind capacity over the course of the next fifteen years. In theory, this makes the case for South Africa to act as a "critical regional node" as described DTI Minister Davies in 2012. Yet the data collection revealed little appetite for proactive engagement with other countries in Sub-Saharan Africa. Firms were focused on South Africa as the primary target for sales as the market was already established and the country's policies were the main reason for establishing operations. The presence of several renewable energy targets in other nations were met with scepticism from some from the industry, and others surmised that without the advantage of local content requirements, they would not be able to compete with other manufacturers on cost. Finally, two firms alluded to the costs of permitting and transporting by road to neighbouring countries: it becomes expensive, weakening the notion that the South African wind industry can inevitably dominate the market.

The small and medium sized wind turbine industry has greater flexibility to sell to other countries, avoiding as steep transportation costs or cumbersome policies related to IPP's. One firm already has done business in several other African countries, and suggested the company maintained an advantage given its familiarity with the region. Regional trade agreements may also give South African firms another advantage. Therefore, actors in the distributed wind industry considered themselves well positioned to develop the regional market- yet at present they may lack the economies of scale or policy incentives to make a considerable impact.

4.2 Findings: Solar Energy

The Varied Value-Add of the Local Solar Industry

Consisting of twelve firms in total, solar manufacturing in South Africa is predominately concentrated in low value activities, such as assembly, machinery operation, or transportation. Firms that have remained in operation rely on a largely unskilled workforce for activities, such as soldering cells into strings or frames. While these activities require a degree of training, they do not demand education. Senior level staff- such as a production manager or lead engineer- are frequently trained overseas or have immigrated to support the company. Some companies that once maintained operations and have since shut down have transitioned into service providers: importing products from overseas and facilitating

the installation of these products. Hence, the South African solar industry is largely concentrated at lower value activities in the broader global value chain.

Innovation in Solar Manufacturing Firms

Despite the broader nature of the industry, there is a presence of higher value activities taking place in the solar manufacturing industry in South Africa. One firm, based out of a university in the Western Cape, is home to the only South African-designed and manufactured panel. Its relationship to the university highlights a technological innovation system in the sector, even if the number of skilled employees at the firm is small. Innovative activities at other firms was limited. One company, which designs and sells off-grid products in South Africa, offshored manufacturing products to Taiwan or South Korea as the cost of production was too high. Two other solar companies indicated plans to move into higher-value activities. One pointed out that most of the processes at the new plant are largely automated and therefore not require a considerable number of new skilled workers. Given the nature of production, there is limited opportunity for innovative practices at the new plant. One large company indicated that no major innovation and R&D are likely to take place locally, because the market is too small to justify opening a new lab in the region. If a large firm had no reason to localize innovative activities, there is little reason for domestic company, with fewer financial resources and technical expertise, to do so either.

That said, one company, based in the Western Cape, provides an interesting counterexample this narrative. Using patents and research from South African universities, it was able to design and manufacture solar panels using 80% local materials. Interestingly, these initiatives were supported by the IDC but predated the RE-IPPPP, indicating that innovation took place with a targeted, demand-side program. Given this clear innovation system created by local universities and partnerships with foreign firms, South Africa may indeed be able to 'leapfrog' over the solar manufacturing step into OEM, branding, and R&D. This example challenges Lewis and Wiser's (2007) notion that green industrialization must take place in a "staged" manner; developing countries with strong academic institutions may not need to upgrade into the manufacturing stage before engaging in R&D. However, there is a case to be made that this company- that has worked on this technology for over twenty years- is more of an anomaly than a foreshadowing.

In sum, innovation in the local solar industry appeared to be limited to a small number of skilled employees, or at companies that specialize in designing off-grid solar products.

Upgrading Strategies of Solar Manufacturing Firms

Given the limited scope of innovative activities in the domestic solar industry, it was not surprising solar manufacturing firms did not demonstrate upgrading, or moving into higher-value activities, was a major trend. Just one firm had concrete plans to move from assembly into manufacturing. The firm cited that the increasingly local content requirement was the primary reason for the decision. It noted that this move would not generate considerable employment for the local economy, as a great portion of activities in solar manufacturing are automated. Another firm, also with considerable market share, indicated it would not move into higher value activity unless local content requirements are strengthened, as it is currently more lucrative to keep those functions at the parent company abroad. Upgrading at this firm appeared to be primarily process upgrading.

While the two largest firms demonstrated some form of upgrading, others either had either closed their operations or indicated no plans to move into higher value-add activities. These firms gave numerous reasons for shutting manufacturing operations or leaving the market entirely. The most frequent citation was weak demand: the commercial and residential market was "too dry," uncertainty around the future RE-IPPPP would cause boom-and-bust cycles, or there would not be enough customers to sustain demand in the long term. One company president indicated that he could not show the firm's investors that there was a "viable pipeline" for opening up a manufacturing facility in South Africa. Furthermore, legal barriers made capital investment challenging. One firm noted that the Black Economic Empowerment (BEE) requirements- South Africa's affirmative action laws- made it difficult to open operations in South Africa. For a foreign company with no experience in this type of legal framework, this was an important barrier to operations. Three firms noted that labour costs were unreasonably high; employees needed to be paid higher than they were worth to the company, given their set of skills. In sum, this caused one former firm leader to note that "no reasonable businessman would open up a manufacturing facility here." Hence, market conditions, coupled with legal barriers, inhibited upgrading activities for some solar firms in South Africa.

Skills Development of Solar Manufacturing Firms

At present, solar manufacturing jobs in South Africa do not require substantial education or training; yet a small subset of the industry contains high value activities like research and design, branding, and OEM. A notable complaint among solar firms that had closed operations were the lack of skills. One company president noted there is an undersupply of local workers with in technical and engineering skills, thus it was expensive to attract- and retain- skilled labour. Furthermore, the workers that one did train would

be able to move into other industries for lucrative work- hence, the solar industry faced a similar problem as the wind industry in the boom-and-bust cycles in the renewable energy market.

The South African government's efforts to train workers in the industry yielded payoffs for larger companies, however. With the support of public programs, workers had received specialized training, and had incentives to stay in the industry. By engaging with the South African government and educational institutions, two solar firms were able to identify mechanisms to retain workers and ultimately, its local operations. Another company that had closed in part because of a lack of available skills, corroborated this point. The firm's former president suggested that the efforts of GreenCape and Stellenbosch University to bolster the industry's workforce could improve the outlook for the industry and ultimately make it easier to stay in business.

One solar firm noted that like many other sectors, photovoltaic production is increasingly performed by machine, as innovations from overseas are making it easier to automate panel manufacturing. It was also noted on several occasions job creation benefits are greater in the deployment stage of renewable energy. Two firms noted that they believed future public policy aimed at job creation will focus more on construction and deployment rather than manufacturing.

The consolidation of solar companies yielded an important impact to workforce development in the industry as well. One company reported that identifying and attracting workers was not a problem in the wake of layoffs from competitors. Thus, the shutting down of one company has a double-benefit to another: not only does it have one fewer competitor, but it can hire former staff without having to invest in training.

Two firms noted that their staff engaged in higher value activities had been educated abroad, typically in Europe, China or the United States. Whether staff had been selected for a reverse trade mission, went overseas for higher education, or was a foreign national, their experience at foreign companies had been integral to continuing and expanding local operations. The retention of these members was noted as critical to the operations of the company.

Regional Development Strategies of Solar Manufacturing Firms

The data did not suggest that regional opportunities are of importance to local utility scale solar manufacturing firms. Those that operated, or once operated, manufacturing and assembly had moved to South Africa for the domestic market- notably the local content requirement of the RE-IPPPP- rather than the proximity to other African nations or to take advantage of favourable bilateral trade

agreements. One company that once assembled off-grid solar products (and now imports them for retail) had a different experience. The company president indicated their presence in South Africa "has less to do with policy and more to do with the need to electrify the country." Another solar component manufacturer noted that it initially had opened doors to gain a foothold in the regional market, yet over 80% of business remained in South Africa. This was largely due to market size: demand for their product was highest in populated regions.

While certain firms mentioned they were monitoring policy developments and market trends in Sub-Saharan Africa, none expressed financial commitment to establishing a strong presence within the region. The most positive expression of regional market development was from a large utility scale solar manufacturer, which indicated its global presence and existing contacts helped tap neighbouring markets and to leverage capital from the International Finance Corporation (IFC). Other firms noted that most of the demand was from South Africa, and it remains the best market for growth. One doubted the renewable energy targets set by other countries were technically infeasible, or the country lacked the appropriate infrastructure to achieve those goals. Hence, unless local policymakers implemented a program with considerable financial backing, firms were reluctant to devote resources to establishing a presence there.

Finally, as solar panels are easier to transport by air or sea, local firms noted that location was not a strong comparative advantage against foreign competitors. Ground transportation infrastructure in Southern Africa is limited, hence most companies opted to ship products to ports in other parts of the continent. The only company that worked extensively in other parts of the continent already held a large global presence, and could leverage its networks to cost-effectively sell into new markets. As South Africa is home to a strong local content requirement and other major utility-scale policies developing solar energy, companies are more focused on domestic opportunities.

4.3 Analysis

The research applied the theoretical framework of Vertically Specialized Industrialisation (VSI) to the governance strategies of solar and wind manufacturing firms in South Africa. Strategies were evaluated by four key characteristics of VSI: innovation, upgrading, skills development, and regional market expansion. The level of engagement on each of these components revealed to what extent firms were responding to the South African government's push to industrialize through VSI.

Most findings indicated South African wind and solar manufacturing firms are not currently pursuing strategies associated with VSI, and therefore do not yet contribute significantly to broader industrial policy priorities. However, there are a small number of large, supplier firms in the solar sector that have potential to upgrade should the national government and state-owned utility collaborate to strengthen market demand through robust policy. Furthermore, the distributed solar and wind industry offers an opportunity to an economy striving to determine comparative advantages in a competitive global industry.

The analysis of private-sector governance strategies are outlined below. These findings highlight how firms are focusing on short term demand growth, advocacy on behalf of better deployment policies, streamlining costs through automation, hedging against Asian competition, and prioritizing local market development. The data also reveal how firms consider opportunities in the distributed sector an era of utility-scale uncertainty.

Policy Uncertainty and Weak Demand Stymie Upgrading and Innovation

An unstable domestic market emerged as the primary theme throughout all conversations. Many firms were more concerned with staying in business rather than upgrading or investing resources in innovation. Most firms indicated that Eskom slowed their operations by not moving forward with additional independent power producers, or that the South African renewable energy market did not grow at the pace they originally believed it would. Thus, immediate concerns of viability overshadow strategies to pursue upgrading beyond improving the efficiency of the firm. Indeed, this observation supports Lewis and Wiser's (2007) point that domestic demand is the "essential foundation" of green IP, and it should not only be sizeable and stable to ensure the viability of manufacturing.

The RE-IPPPP was at the centre of policy concerns, as it has been the primary driver of renewable energy demand in South Africa. Firms expressed reluctance to invest in additional capital or skills development until there is confidence the program will ensure a viable market. Some businesses interviewed opted to close down completely, or scale down operations to focus on retail or service provision. Advocacy, through organizations such as SAREC, was a key priority for some businesses to securing the existence of a future market.

The RE-IPPPP effectively served as the linchpin for upgrading and innovation, which ultimately is problematic in the context of VSI. Eleven municipalities had or were passing feed-in tariffs to facilitate distributed generation, yet no business leader interviewed stated that commercial or residential

demand growth was strong enough in the near term to solely justify expanding operations. Milberg, Jiang and Gereffi (2013) emphasize local suppliers require several buyers in order to diversify customers and spread risk. However, in the case of South Africa, there is just one buyer of utility scale electricity: Eskom. Hence, should policymakers wish to engender long term certainty in the renewable energy market, they may consider mechanisms to build new markets in the industry. One option is to develop the commercial and residential sectors to hedge against utility scale uncertainty. These markets may provide stability should the utility-scale market, underpinned by the RE-IPPPP bids, undergoes further boom and bust cycles. Otherwise, business leaders are unable to invest in innovation and upgrading, stagnating the progress of the local solar and wind industries.

Automation and Labour Economics Undermine Industrialization Goals

Job creation is major priority of the South African government's industrial policy, and in theory local economic development concerns are weighted as 30% of the bid in the RE-IPPPP. This is an especially challenging goal within an industry increasingly reliant upon automation, and in an economy with relatively high labour costs. A number of respondents indicated wages in South Africa were high compared to the skills and training of the local workforce. This factor was critical: manufacturers that had suspended or shut down operations cited labour costs a major factor in their decision. Some suggested that the resulting low revenue margins dissuaded labour intensive activities, hampering decisions to upgrade into manufacturing. These economic trends indicate job creation in the solar industry is better suited in the deployment, rather than manufacturing, sector. Indeed, one senior official at a large firm remarked that the government's decision to increase the local content requirement was an economically inefficient means of creating jobs. Rather, stimulating new construction of projects may be a more cost-effective way to ensure employment.

Lack of skills, and high labour costs caused another key impediment to upgrading and sector growth. An industry plagued by boom-and-bust cycles was disproportionately harmed in an economy with a shortage of skilled labour. In the wind and solar sectors, should workers gain additional skills but not offered consistent opportunity, they sought opportunities elsewhere and did not return. A key component of an innovation system is consistency: thus the nature of the labour market undermines innovation in the wind and solar industry. Gosens, Lu and Coenen (2015:15) note the impact of the "brain drain" on technology innovation systems, and suggests that incentives to stay in the industry are central to its growth. This point relates to an earlier observation about policy uncertainty and market demand, and demonstrates how a volatile market can impact a firm in both the short and long term.

Comparative Advantages in Wind and Solar Remain Unclear

As noted in the literature review, an industrialization policy accepts that firms may specialize in activities in which they do not have comparative advantage, at least in the short term. By protecting infant industries from foreign competition, trade and procurement policy can ensure the domestic sector will be competitive on an international scale in the long term. Indeed, many solar and wind firms mentioned that despite the local content requirements, favourable tax credits and other policy incentives, the role of foreign competition still loomed large over their long-term governance strategy. Nearly all firms cited China as a critical factor in doubting the viability of investments in upgrading or innovation. As noted by Kaplinsky and Morris (2008), China, and other Asian countries, can pose a dual-threat to South African firms. As mentioned above, the cost of labour in South Africa tends to be higher in comparison to other developing countries. Asian companies compete by maintaining lower labour costs. Second, interest rates are typically lower in China, which make for a lower cost of capital- facilitating greater opportunity for business development. One firm president noted he closed South African manufacturing operations because capital investments in Asian markets were much cheaper. This implies that renewable energy IP in the context of VSI is especially challenging in South Africa, as upgrading, innovation, and other investments in human capital are expensive yet tantamount.

Furthermore, unlike many other developing countries, the Chinese renewable energy industry can also compete on innovation. Chinese businesses prefer to keep high-value activities within national borders; no firm with partnerships in China cited major investments in innovation in South Africa. These findings confirmed a point made by Carwell (2013), who noted that foreign solar manufacturers have been defensive of their role in innovation in the global market. Hence technology in the sector is more often imported rather than transferred). Similarly, German and American manufacturers have not prioritized skills transfer in other countries (Carwell, 2013). Thus, South Africa will need to rely on its local educational institutions, and attract workers trained abroad, to develop proprietary technology in the field.

Given these constraints on maintaining skilled labour within the industry, it may be possible the renewable energy industry in South Africa could fall into the “middle income trap” as described by Milberg, Jiang and Gereffi (2013), whereby the industry does not progress into higher value activities due to lead firms’ keeping these activities within national borders. The reason for this phenomena in the case of South Africa may be two-fold: the market for South African solar is too small to justify major investments in innovation, and LCR’s-which brought foreign solar companies to South Africa in the first

place- do not specifically account for these higher value add activities. In other words, public policy has been the main driver for solar firms to enter each stage of manufacturing, and without incentive to localize R&D, it is unlikely to happen on a significant level in South Africa.

The presence of South Africa's universities and government-sponsored workforce development provided certain firms with confidence the country's renewable energy industry may eventually stake comparative advantages in innovation. According to one firm, the government sends a signal to the global industry when it invests in public education, reverse trade missions, and workforce development. Indeed, one firm tapped the local innovation system in the Western Cape- particularly Stellenbosch University- to develop and manufacture an original and proprietary solar module. Yet this achievement was supported through a joint-partnership with a German company, corroborating Gallagher and Zhang's (2013) observation that technology transfer is central to upgrading in global value chain oriented industrialization. Upgrading into high value activities in the South African renewable energy industry will demand that both local firms and foreign companies are engaged within the technology innovation system.

Regional Opportunities Are Limited

In general, utility scale manufacturing firms did not strongly prioritize regional market development. All cited low demand: lack of access to capital and poor existing grid infrastructure make renewable energy development a challenge in Sub Saharan Africa. Furthermore, some firms noted poor transportation infrastructure as a factor to dissuade regional market penetration. This issue was especially relevant to wind manufacturing firms, where heavy components can require specialized transportation infrastructure. In this sense, transportation barriers raise costs, weakening South Africa's comparative advantage of trade agreements and proximity against countries that are able to ship the components to the national ports.

In the context of VSI, the renewable energy industry did not seem to benefit significantly from regional market development opportunities. As noted earlier by the World Bank, EFP, and Milberg, Jiang and Gereffi (2013), South Africa is the clear headquarter economy of Southern Africa, and provides neighbouring economies with a substantial portion of trade. But the renewable energy industry has yet to significantly influence these markets. Solar and wind generation are not yet in high demand: despite policy signals from governments, such as Namibia or Botswana, there have yet to be major public commitments to ensure stable demand for solar panels or wind turbines. As one firm president noted, businesses doubt many of the stated renewable energy targets of these countries, and consider such

commitments as technical infeasible. Hence, the products from South African renewable energy firms are likely to stay in South Africa in the near term.

This discovery demonstrates a potential mismatch between VSI-based strategies and green industrialization. VSI has typically applied to consumer goods that have relatively stable demand, such as textiles, agricultural products, minerals beneficiation, automobiles, or electronics. However, utility-scale electricity generation has a limited number of buyers, and demand for power purchase agreements is often erratic. The element could be added to Pegels' (2014) list of idiosyncrasies of green industrial policy. From this observation, one can surmise that unless the South African government can incentivize distributed generation to make solar (or small wind) accessible to a larger set of consumers, therefore spreading risk, the global value chain oriented strategy of industrialization may not have as effective an impact.

Off-grid Solutions Offer Opportunity

As indicated earlier, a utility scale regional development strategy is uncommon among South African firms. However, many firms acknowledged operations in South Africa provide an important springboard for supplying off-grid energy systems to rural communities in the region. In fact, one company moved to the country in order to market off-grid products to consumers throughout Sub-Saharan Africa. One small wind firm CEO noted his company had a comparative advantage in Sub-Saharan Africa given his staff's familiarity with the culture, trade policy, languages, climate, and physical conditions. Others suggested that international investment in rural electrification could be an opportunity for their firm to hedge against lowered demand in more-electrified South Africa. These observations demonstrate that unlike in the utility scale sector, South Africa holds comparative advantages in supplying off-grid products to consumers with little access to electricity. Given manufacturers in Europe and the United States have little direct experience with energy poor consumers, South African firms are able to tap local expertise to design and market products- such as solar powered phone chargers or lanterns- in the distributed sector.

Meanwhile, the small and medium wind turbine sector provides a strong basis to apply an upgrading strategy. Off-grid wind, which can provide power to farms and other remote communities, may have greater opportunity for development as demand is more stable. The state-owned utility does not wield exclusive power over the market, and commercial customers- especially in remote areas- are found in much greater numbers. Furthermore, the sector does not need as complex infrastructure to distribute and install products. An owner of a small wind firm alluded to his company's comparative advantage in

working throughout Africa. Hence, given this sectors' current success despite few policy incentives, it is worth it for the DTI to consider targeted policies to enable greater innovation and upgrading in the space.

In Summary

From the evidence stated above, the author finds that despite the South African government's concerted efforts to apply a VSI-based strategy to the wind and solar manufacturing industry, firms are largely not developing upgrading and regional development governance strategies. This is demonstrated by several factors, including the departure of local firms from operating in South Africa, an absence of major intentions to pursue functional upgrading, preference to pursue capital rather than labour-intensive investments, an immediate emphasis on business development and policy advocacy rather than innovation, and the absence of new companies entering the local market. Regional development strategies do not appear to be present amongst utility scale firms either, as neighbouring markets are not strong enough to justify expanding operations. Furthermore, South African firms' location does not overcome foreign competitors' advantages at cost of production and efficiency.

From these observations, the author concluded that vertically specialized industrialization in the context of green industrial policy requires policy certainty, several markets and buyers, and a clear, long term comparative advantage within the domestic economy. In the case of South Africa, the size of the local market is not stable nor sizeable enough to warrant innovation or upgrading policy, and neighbouring markets are not strong enough to offer significant opportunity. However, the South African government may apply a similar industrialization strategy to the off-grid market, where there is a substantial and long term demand for products. Furthermore, the local workforce has more familiarity with energy poverty, and perhaps the needs of local communities, hence domestic firms hold a comparative advantage against competitors in Europe or the United States.

5. Concluding Remarks

The purpose of the study was to determine in what ways local solar and wind firms are pursuing upgrading and regional development strategies associated with Milberg, Jiang, and Gereffi's concept of Vertically Specialized Industrialization. The researcher selected the conceptual framework as the South African government, namely the DTI, had stated its intention for the country to pursue global value chain oriented industrialization. During the last seven years, the government implemented a suite of policies in the renewable energy sector associated with VSI. The methodology aimed to assess the governance strategies of local wind and solar energy firms to determine if firms were responding by in turn pursuing upgrading, innovation, skills development and regional market development.

The approach of this study was novel because as at the time of publication is the only study to explicitly apply the VSI framework to the renewable energy sector in South Africa. The data collection process consisted of firm-level interviews with senior leaders at local firms, and used several metrics- such as participation in green industrial clusters, engagement with public institutions to improve workforce development, and clear innovation policies- to assess the company's upgrading and regional market development strategy. As the data set was relatively limited, the author compared the findings to publically-made observations from other industry leaders and independent reports.

The findings revealed that despite the South African government's concerted effort to localize a wind and solar manufacturing industry, firms are largely not developing upgrading and regional development governance strategies associated with Vertically Specialized Industrialization. Casual factors included policy uncertainty, weak domestic demand, significant comparative disadvantages (such as a relatively high cost of labour), and the little market development opportunities from neighbouring countries. In the wind sector, there appears to be less incentive to pursue either upgrading or regional market development, as the market relies on utility-scale demand- which at present is limited. As for the solar sector, there appears to be a greater likelihood for upgrading among select companies. Companies have moved into manufacturing, and one firm has already localized research and development. That said, the competition from foreign firms may be too great move beyond the "middle-income trap," stymying innovation and OEM for the foreseeable future. It is for these reasons that the research demonstrated local solar and wind firms are largely not pursuing governance strategies associated with VSI.

As this study was the first to analyse the renewable energy manufacturing sector specifically through VSI, there are many observations significant to the field of literature. First, the VSI framework is typically applied to consumer goods, such as textiles, automobiles, or household items. Demand for such items is generally tied to household income and economic advancement. Utility-scale wind and solar farms, on the other hand, are sold in a monopsony. Therefore the nature of domestic demand depends on the single buyer. In the case of South Africa, the power of Eskom over sales radically shaped the business model of local firms given weak demand in neighbouring countries. Thus, the governance strategies of suppliers inevitably hinged on the utility- rather than a number of consumers- in the context of the utility-scale renewable energy value chain. This implies that global value chain oriented industrialization may be best pursued in markets with relatively stability and many buyers.

Second, the research demonstrated how capital and labour requirements of a solar and wind energy value chain are atypical of other industries often protected as industrialization policy. As noted earlier, solar panel manufacturing is increasingly automated; assembly typically demands more jobs. Job creation is often a paramount public priority that operates in tandem with global value chain integration; the findings suggest that functional upgrading should not be pursued beyond installation and assembly of solar panels should government wish to maximize employment from investment. Wind, on the other hand, requires both specialized skilled labour and low-skill labour at each stage of manufacturing. However, the size and capacity of the turbines limits the marginal return of upgrading. Thus, for a country like South Africa with limited existing technical capacity, there is not as strong an incentive to pursue innovation in the sector. Hence, high-value activities in the wind sector are likely to remain in countries in Asia, Europe and the United States.

Third, this research sheds light on how the price of a product will impact the viability of localization. The dynamic nature of renewable energy technology resulted in considerable cost declines over time. As Eberhard, Leigland and Kolker (2014) noted, the origin of the South African wind and solar industry began in the early 2010s as a glut in the market enabled developing countries to purchase renewable energy equipment for low prices. The incentive for Chinese, European, and North American companies to enter the South African market was driven not by favourable production costs, but rather an entry requirement for selling a product. Localizing production was an original goal of the South African government, not necessarily foreign firms, thus companies only started manufacturing operations to enable them to sell products in the country. This is a gamble on an infant industry: should the price of the product continue to decline, the value of localization should also decrease. Thus, South Africa

struggled to protect an infant industry in an increasingly competitive environment, leading to a diminished return on investment from localization. This evidence provides caution to other countries pursuing a green industrial policy in era of rapidly declining technology prices.

This research offers many opportunities for further exploration. As mentioned earlier, there may be greater value to repeat this study with a local interviewer with existing connections the industry, to access more participants and provide additional credibility as an independent researcher. Second, this study may be repeated once the solar and wind markets have had more time to mature: thus providing more time to examine companies that have pursued upgrading and regional market development. Third, one could have applied a different methodology of GVC analysis. For example, a researcher could apply an internationalist, rather than industrialist approach of analysis, by using quantitative data, such as trade statistics, FDI, and other macro-level evidence to evaluate South Africa's role in the global wind and solar value chain. Fourth, the research revealed the important role of off-grid solutions to the local renewable energy industry and region. There may be considerable value in narrowly focusing on how upgrading and regional market development take place in the distributed energy sector, giving South Africa's apparent comparative advantage in this sector. Finally, this research model could be applied to other countries with similar localization strategies in the solar and wind sector. Kenya or India may offer case studies to researchers looking to apply VSI-framework to the domestic renewable energy sector.

This research revealed how green industrial policy in the era of Vertically Specialized Industrialization requires significant commitment and coordination from domestic policymakers, lead firms, and local companies. By using an industrialist approach to global value chain analysis, it contributed to the research gap in firm-level interviews exploring the upgrading and regional market development strategies of local solar and wind energy firms. This was an important contribution to both the literature on green industrial policy, in addition to GVC-oriented analyses of South African industry. The findings point to the ways in which renewable energy is an inherently a unique sector as it relates to industrialization and innovation. The evidence was magnified in a fossil-rich country like South Africa, and leads one to question how infant industries in the energy sector may be cultivated to compete against entrenched interests. Ultimately, it speaks to the immense challenges, and potential rewards, of pursuing industrial policy with strong social and environmental purpose.

References

African Development Bank Group. 2014. *Global value chains and Africa's integration into the global economy.* Annual report 2013. Abidjan, Côte d'Ivoire.

African Development Bank Group. 2017. *Statistics*. African economic outlook 2017. Abidjan, Côte d'Ivoire.

Altenburg, T. & Pegels, A. 2012. Sustainability-oriented innovation systems–managing the green transformation. *Innovation and Development*. 2(1):5-22.

Altman, M. & Mayer, M. 2003. Overview of industrial policy. *Human Resources Development Review*.

Ahlfeldt, C. 2013. *The localisation potential of photovoltaics and a strategy to support large scale roll-out in South Africa*. Availalble: http://www.wwf.org.za/media_room/publications/?8541/The-localisation-potential-of-Photovoltaics-and-a-strategy-to-support-the-large-scale-roll-out-in-South-Africa [2016, January 15]

Baer, W. 1972. Import substitution and industrialization in Latin America: experiences and interpretations. *Latin American Research Review*. 7(1):95-122.

Baker, L. 2015. The evolving role of finance in South Africa's renewable energy sector. *Geoforum*. 64: 146-156.

Barrett, R. & Chin, S. 1987. Export oriented industrializing states in the capitalist world system: similarities and differences. *The Political Economy of the New Asian Industrialization*. Cornell Studies in Political Economy.

Calitz, E., Wallace, S. & Burrows, L.R. 2013. The impact of tax incentives to stimulate investment in South Africa. International Center for Public Policy Working Paper Series. 37. Available: http://scholarworks.gsu.edu/icepp/37 [2015, December 21]

Carwell, H. 2013. Solar energy industry future uncertainty-an opportunity for new markets and refocusing. *African Journal of Science, Technology, Innovation and Development*. 5(4):319-326.

Chang, H.J. 1998. Evaluating the current industrial policy of South Africa. *Transformation: Critical Perspectives on Southern Africa.* 36:51-72.

Chang, H.J. & Amsden, A.H. 1994. *The political economy of industrial policy.* London: Macmillan.

Cimoli, M., Dosi, G., Nelson, R. & Stiglitz, J. 2006. Institutions and policies shaping industrial development: an introductory note. *LEM Papers Series*. 2:2006-02.

Cimoli, M., Dosi, G. & Stiglitz, J. 2009. *Industrial policy and development: The political economy of capabilities accumulation.* Oxford University Press. ISBN 978-0-19-3527-8.

Dalle, D., Fossati, V. & Lavopa, F. 2013. Industrial policy and developmental space: the missing piece in the GVCs debate. *Revista Argentina de Economía Internacional*.

Davies, R. *Keynote address of Minister of Trade and Industry, South Africa: Dr Rob Davies*. Capturing the Gains Global Summit. Cape Town, December 2012. Available: http://www.capturingthegains.org/pdf/Rob_Davies_Keynote_CtG_Summit_Dec_2012.pdf [2016, January 12].

Department of Economic Development. 2011. *New Growth Path*. Pretoria: Department of Economic Development.

Department of Trade and Industry 2014. Industrial Policy Action Plan 2014. Pretoria: Department of Trade and Industry.

Department of Trade and Industry. 2015. *The Wind Energy Industry Localisation Roadmap in Support Of Large-Scale Roll-Out In South Africa.* Pretoria: Department of Trade and Industry.

Di Maio, M. & Valente, M. 2013. Uncertainty, specialization and government intervention. *Metroeconomica*. 64(2):215-243.

Eberhard, A., Leigland, J. & Kolker, J. 2014. South Africa's renewable energy IPP procurement program. *World Bank Publications.*

Economic Policy Forum and South African Institute of International Affairs. 2015. Drivers of Regional Integration: Value Chains, Investment and New Forms of Co-operation. Economic Policy Forum and South African Institute of International Affairs. Berlin, Germany.

Fine, B. & Rustomjee, Z. 1996. *The political economy of South Africa: from minerals-energy complex to industrialisation.* London: C. Hurst & Co Publishers Ltd.

Gallagher, K.S. & Zhang, F. 2013. Climate Technology & Development Case study: Innovation and Technology Transfer Across Global Value Chains: Evidence from China's PV Industry.

Gereffi, G. & Fernandez-Stark, K. 2016. Global value chain analysis: a primer.

Gereffi, G. & Lee, J. 2012. Why the world suddenly cares about global supply chains. *Journal of Supply Chain Management.* 48(3):24-32.

Gereffi, G. & Sturgeon, T. 2013. 14 Global value chain-oriented industrial policy: the role of emerging economies. *Global Value Chains in a Changing World*. 329.

Gereffi, G. 1999. A commodity chains framework for analyzing global industries. *Institute of Development Studies*. 8(12):1-9.

Global Wind Energy Council. 2012. *Global Wind Energy Outlook 2012.* Brussels, Belgium. Available: http://www.gwec.net/wp-content/uploads/2012/11/GWEO_2012_lowRes.pdf

Gosens, J., Lu, Y. & Coenen, L. 2015. The role of transnational dimensions in emerging economy 'Technological Innovation Systems' for clean-tech. *Journal of Cleaner Production*. 86:378-388.

GreenCape. 2016. Utility-scale renewable energy sector - 2016 Market Intelligence Report. Cape Town, South Africa. Available: http://greencape.co.za/assets/GreenCape-Renewable-Energy-MIR-2016.pdf [2017, March 12].

Grossman, G.M. & Helpman, E. 1990. Trade, innovation, and growth. *The American Economic Review.* 80(2):86-91.

Humphrey, J. & Schmitz, H. 2002. How does insertion in global value chains affect upgrading in industrial clusters?. *Regional Studies*. 36(9):1017-1027.

Iizuka, M., Dantas, E. & Freitas, I.M.B. 2015. The diffusion of renewable energy technologies in the BRICS. *Structural Change and Industrial Development in the BRICS*. 408.

International Renewable Energy Agency. 2014. Charts: Wind. IRENA. Abu Dhabi. Accessible: http://costing.irena.org/charts/wind.aspx [2017, October 9].

International Renewable Energy Agency. 2015. Africa 2030: Roadmap for a Renewable Energy Future. Abu Dhabi. Accessible: www.irena.org/remap [2016, January 18].

Kaplinsky, R. & Morris, M., 2008. Do the Asian drivers undermine export-oriented industrialization in SSA?. *World Development*. 36(2):254-273.

Lam, D., Leibbrandt, M. & Mlatsheni, C. 2008. Education and youth unemployment. SALDRU Working Paper, UCT.

Lee, K., Park, T.Y. & Krishnan, R.T. 2014. Catching-up or Leapfrogging in the Indian IT service sector: windows of opportunity, path-creating, and moving up the value chain. *Development Policy Review*. 32:495-518. DOI:10.1111/dpr.12065.

Lema, A. & Lema, R. 2016. Low-carbon innovation and technology transfer in latecomer countries: insights from solar PV in the clean development mechanism. *Technological Forecasting and Social Change*. 104:223-236.

Lewis, J.I. & Wiser, R.H. 2007. Fostering a renewable energy technology industry: an international comparison of wind industry policy support mechanisms. *Energy Policy*. (35)3:1844-1857.

Lorentzen, J. & Barnes, J. 2004. Learning, upgrading and innovation in the South African automotive

industry. *European Journal of Development Research*. 16(3):463-495.

Lund, P.D. 2009. Effects of energy policies on industry expansion in renewable energy. *Renewable Energy*. 34(1):53-64.

McCallum, J. 2011. Export processing zones: comparative data from China, Honduras, Nicaragua and South Africa. Working Paper, International Labour Office. Geneva, Switzerland.

Milberg, W., Jiang. X. & Gereffi G. 2013. Industrial policy in the era of vertically specialized industrialization. *Industrial Policy for Economic Development: Lessons from Country Experiences*. Geneva: ILO-UNCTAD.

Mitchell, C. & Connor, P. 2004. Renewable energy policy in the UK 1990-2003. *Energy Policy*. 32(17):1935-1947.

Mohamed, S. 2012a. The impact of the global financial crisis on the South African economy. *The Global Economic Crisis and the Developing World: Implications and Prospects for Recovery and Growth*. (95):253.

Mohamed, S. 2012b. The impact of capital flows on the South African economic growth path since the end of apartheid. *Working Paper Series 2: Financial Markets and International Regulation*. The AUGUR Project.

Morris, M. & Martin, L. 2015. *Political economy of climate-relevant policies: The case of renewable energy in South Africa* (No. IDS Evidence Report; 128). IDS/University of Cape Town.

Morris, M., Kaplinsky, R. & Kaplan, D. 2012. *One thing leads to another: promoting industrialisation by making the most of the commodity boom in sub-Saharan Africa*. Lulu. com.

Morrison, A., Pietrobelli, C. & Rabellotti, R. 2008. Global value chains and technological capabilities: a framework to study learning and innovation in developing countries. *Oxford Development Studies*. 36(1):39-58.

Nahm, J. & Steinfeld, E.S. 2014. Scale-up nation: China's specialization in innovative manufacturing. *World Development*. 54:288-300.

Newman, S. & Takala-Greenish, L. 2014, May. African Industrialisation: Is Global Value Chain Development the Answer?'. In Joint South Africa-EU initiative, TIPS and Dialogue Facility Conference: International Conference on Manufacturing-Led Growth for Employment and Equality.

Novick, G. 2008. Is there a bias against telephone interviews in qualitative research? *Research in Nursing & Health*. 31:391-398.

Nurse, K. 2012. 3 The slowing down of the engine of growth. *The Global Economic Crisis and the Developing World: Implications and Prospects for Recovery and Growth*. (95):47.

OECD. 2014. Global value chains and Africa's industrialisation. *Organisation for Economic Co-operation and Development, United Nations Development Programme: African Development Bank*.

Pahle, M., Pachauri, S. & Steinbacher, K. 2016. Can the green economy deliver it all? Experiences of renewable energy policies with socio-economic objectives. *Applied Energy*. 179:1331-1341.

Palley, T.I. 2011. The contradictions of export-led growth (No. 119). Public policy brief/Jerome Levy Economics Institute of Bard College.

Pegels, A. & Lütkenhorst, W. 2014. Is Germany's energy transition a case of successful green industrial policy? Contrasting wind and solar PV. *Energy Policy*. 74:522-534.

Pegels, A. 2014. Green industrial policy in emerging countries (Vol. 34). Routledge.

Perrot, R. 2012. The dynamics of renewable energy transition in developing countries-The case of South Africa and India.

Pietrobelli, C. & Rabellotti, R. 2006. Clusters and value chains in Latin America: in search of an integrated approach. Upgrading to compete: global value chains, clusters, and smes in Latin America. 1-40.

Power, M., Newell, P., Baker, L., Bulkeley, H., Kirshner, J. & Smith, A. 2016. The political economy of energy transitions in Mozambique and South Africa: the role of the rising powers. *Energy Research & Social Science*. 17:10-19.

Rennkamp, B. & Westin, F.F. 2013. Feito no Brasil? Made in South Africa? Boosting technological development through local content requirements in the wind energy industry. University of Cape Town.

Ricardo, D. 1817. On foreign trade. Principles of political economy and taxation.

Rodrik, D. 2008. Normalizing industrial policy. International Bank for Reconstruction and Development/The World Bank, (pp. 1-50).

Rodrik, D. 2014. The past, present, and future of economic growth. *Challenge*. 57(3):5-39.

Sadorsky, P. 2014. The effect of urbanization on CO 2 emissions in emerging economies. *Energy Economics*. 41:147-153.

Schmitz, H. & Lema, R. 2015. The global green economy: competition or cooperation between Europe and China?. *The Triple Challenge for Europe Economic Development, Climate Change, and Governance*. pp.118-141.

Shafaeddin, M. 2012. 2 Trade liberalization, industrialization and development1. *The Global Economic Crisis and the Developing World: Implications and Prospects for Recovery and Growth*. (95):21.

Soumonni, O. 2013. Towards a technology policy for renewable energy development in Africa: a systems of innovation perspective. *African Journal of Science, Technology, Innovation and Development*. 5(4):289-295.

Spencer, F. 2016. Looking at SA renewables market as we head for a New Year. *ESI South Africa*. 14 December. Available: https://www.esi-africa.com/features/looking-at-sa-renewables-market-as-we-head-for-a-new-year/ [2017, March 4].

UNECA. 2014. Dynamic Industrial Policy in Africa. United Nations Economic Commission for Africa. Addis Ababa, Ethiopia. Available: http://www.uneca.org/sites/default/files/PublicationFiles/final_era2014_march25_en.pdf [2016, January 13].

United Nations Framework Convention on Climate Change (UNFCCC). Greenhouse Gas Inventory Data. Available: http://unfccc.int/ghg_data/items/3800.php

Wood, A. & Berge, K. 1997. Exporting manufactures: human resources, natural resources, and trade policy. *The Journal of Development Studies*. 34(1):35-59.

World Bank. 2016. Access to Electricity (% of population). Available: http://data.worldbank.org/indicator/EG.ELC.ACCS.ZS

Yelland, C. 2016. Latest integrated electricity generation plan dangerously flawed – analyst. *Biz News*. 30 November. Available: http://www.biznews.com/energy/2016/11/30/integrated-electricity-generation-plan-flawed/ [2017, January 5].

World Bank Group. Factory Southern Africa? SACU in Global Value Chains. 2015. World Bank Group. Washington, D.C. Available: http://www.saiia.org.za/non-saiia-publications/969-2016-01-21-saiia-world-bank-factory-southern-africa-full-report/file [2016, January 20].

Zalk, N. 2014. Industrial policy in a harsh climate: the case of South Africa. *Transforming Economies: Making industrial policywork for growth, jobs and development. Geneva: International Labour Organisation*, pp.327-356.

Zhang, F. & Gallagher, K.S. 2016. Innovation and technology transfer through global value chains: evidence from China's PV industry. *Energy Policy*. 94:191-203.

Zhang, S. & He, Y. 2013. Analysis on the development and policy of solar PV power in China. *Renewable and Sustainable Energy Reviews*. 21:393-401.

Zhang, S., Andrews-Speed, P., Zhao, X. & He, Y. 2013. Interactions between renewable energy policy and renewable energy industrial policy: a critical analysis of China's policy approach to renewable energies. *Energy Policy*. 62:342-353.

Annex 1

General

1. What originally drove your business to open doors in South Africa in [year]? And specifically, in [location]?
2. I read your company [primary manufacturing activities], is this still correct?
3. Since [your company] began, have you expanded into other components? If so, what are the latest components that you all make? Do you all plan to grow the types of the products you offer to customers?
4. Do you all have plans to move into other aspects of [sector] production, such as design or branding?

Skills

1. What kinds of training do your staff have?
2. Should demand increase, what skills would you look for new hires?
3. Where would you look for employees with these skills?
4. Are you concerned that there are not enough of candidates with the level of experience to fulfill those roles?
5. If there were more engineers and technicians available in the region, how would this change your products?

Government Support

1. Are you aware of public efforts to increase manufacturing skills in the renewable energy sector?
2. Do you make use of any of these programs?
    a. If yes, how did you benefit?
    b. What can be improved?
3. Do you feel like your business could benefit from government policies aimed at growing manufacturing skills in this sector?
    a. If yes, what would be beneficial for you?
4. Have you been collaborating with government or public institutions to transform skills development?
5. In your view, how can government best support the industry in the long term?

Regional Markets

1. What are your goals for the next 5-10 years for your business- in terms of market demand, size, and scope?
    a. What are the next steps for business development?
2. South Africa is not the only renewable energy market in the region. Have surrounding countries played a major role in your business's decision to enter this market?
3. Are there particular incentives for your business, and others like it, to export products to other neighbors within the region?

Annex 2

Role	Sector	Current Activities	Former Activities
President	Solar	Design, Retail (Off-grid)	Assembly
CEO	Solar	Retail	Manufacturing
Former President	Solar	None	Component Manufacturing
Business Development Manager	Solar	Retail (Components)	Component Manufacturing
Business Development Manager	Solar	Assembly, Construction	
Regional Business Director	Solar	Assembly, Construction	
Representative	Solar	Design, Assembly	
President	Wind	Design, Manufacturing, Construction	
Business Development Manager	Wind	Manufacturing, Construction	
President	Wind	Manufacturing, Construction (Components)	